Audit Report

OFFICE OF THE INSPECTOR GENERAL

DUPLICATION/PROLIFERATION OF WEAPON SYSTEMS' MODELING AND SIMULATION EFFORTS WITHIN DOD

Report No. 93-060 March 1, 1993

Department of Defense

The following acronyms are used in this report.

ALSP.....Aggregate Level Simulation Protocol
AMRAAM.....Advanced Medium Range Air-to-Air Missile
AMSMO.....Army Model and Simulation Management Office
AMSMP.....Army Model and Simulation Management Program
DARPA.....Defense Advanced Research Projects Agency
DDR&E.....Director, Defense Research and Engineering
DIS.....Distributed Interactive Simulation
DISA.....Defense Information Systems Agency
DMSO.....Defense Modeling and Simulation Office
DSI.....Defense Simulation Internet
EXCIMS.....Executive Council for Models and Simulations
IEEE.....Institute of Electrical and Electronic Engineers
ISPR.....Installed System Performance Reliability
J-MASS.....Joint Modeling and Simulation System
MICOM.....U. S. Army Missile Command
ODS.....Operations Desert Shield/Storm
OSD.....Office of the Secretary of Defense
OT&E.....Operational Test and Evaluation
SAIC.....Science Applications International Corporation
SCAN.....Survivability by Computer Analysis
TRANSMO.....Transportation Model
USD(A).....Under Secretary of Defense for Acquisition
VV&A.....Verification, Validation, and Accreditation

INSPECTOR GENERAL
DEPARTMENT OF DEFENSE
400 ARMY NAVY DRIVE
ARLINGTON, VIRGINIA 22202

March 1, 1993

MEMORANDUM FOR UNDER SECRETARY OF DEFENSE FOR ACQUISITION
ASSISTANT SECRETARY OF THE NAVY (FINANCIAL MANAGEMENT)
ASSISTANT SECRETARY OF THE AIR FORCE (FINANCIAL MANAGEMENT AND COMPTROLLER)
INSPECTOR GENERAL, DEPARTMENT OF THE ARMY

SUBJECT: Audit Report on Duplication/Proliferation of Weapon Systems' Modeling and Simulation Efforts Within DoD (Report No. 93-060)

We are providing this final report for your information and use. The report notes recent positive initiatives to improve the management of models/simulations, but discusses deficiencies requiring further action. Comments to the draft report were considered in preparing this final report and are included in Part IV, Management Comments.

The recommendations are subject to resolution in accordance with DoD Directive 7650.3, in the event of nonresponsive comments. We request that the Director of Defense Research and Engineering reconsider the management position on Recommendation B.1., regarding the need for an enforceable single verification, validation, and accreditation standard. Please provide those final comments by May 1, 1993. Provide completion dates for actions already taken and the estimated dates for completion of planned actions in response to all audit recommendations. We also ask that your comments indicate concurrence or nonconcurrence with the internal control weaknesses highlighted in Part I. No further response from the other addressees is required.

The courtesies extended to the audit staff are appreciated. If you have any questions on the audit, please contact Mr. Raymond Spencer, Program Director, at

(703) 614-3995 (DSN 224-3995) or Mr. David Vincent, Project Manager, at (703) 693-0355 (DSN 223-0355). Appendix I lists the planned distribution of this report.

Robert J. Lieberman
Assistant Inspector General
for Auditing

Enclosure

cc:
Secretary of the Army
Secretary of the Navy
Secretary of the Air Force
Commandant of the Marine Corps

Office of the Inspector General, DoD

AUDIT REPORT NO. 93-060 **March 1, 1993**
(Project No. 2AB-0016)

DUPLICATION/PROLIFERATION OF WEAPONS SYSTEMS' MODELING AND SIMULATION EFFORTS WITHIN DoD

EXECUTIVE SUMMARY

Introduction. Military Departments and Defense agencies have a hierarchy of models/simulations generally oriented to their primary mission. In recent years there has been a significant increase in the number and frequency of use of models/simulations within DoD. Accordingly, Congress and DoD management have become concerned about the potential for duplication and proliferation of modeling and simulation.

Objectives. Our objective was to determine if redundant investment is being made by DoD for modeling/simulation efforts supporting weapon system development. In addition, we evaluated internal controls used to prevent unnecessary investment in models and simulations.

Audit Results. In June 1991, the Deputy Secretary of Defense enacted several initiatives directed at improving management of modeling and simulation in the DoD. Specifically, the Defense Modeling and Simulation Office (DMSO) was established as a focal point in the Department. Concurrent with our audit effort, DMSO drafted a Department of Defense Directive that addresses certain concerns discussed in this report and, when implemented, should assist in improving DoD management of modeling and simulation activities. The audit did, however, disclose three issues requiring further management attention.

o Model and simulation projects are being procured and developed within the DoD without adequate coordination and control. The DoD has not established policy, procedures, guidance, or direction to manage and coordinate Defense modeling and simulation activities. This has resulted in redundant models/simulations and a proliferation of system architectures and libraries **(Finding A)**.

o The vast majority of models and simulations currently used in DoD have not been verified, validated, or accredited. The DoD has no requirement, criterion, or standard by which to accomplish a verification, validation, or accreditation process. Weapon system requirement

decisions, development decisions, engineering designs, operations, and test and evaluation results may be based on computer-generated data that is inaccurate or misleading **(Finding B)**.

o The majority of models and simulations used in DoD lack adequate configuration management and documentation necessary to assure ready access by authorized Defense personnel. This condition exists because of ineffective guidance and lack of oversight by DoD Components **(Finding C)**.

Internal Controls. There is a lack of effective internal controls regarding modeling/simulation in the Military Departments and Defense agencies. Effective policies, procedures, and guidelines to control modeling/simulation development and proliferation have not been established. Additional details are provided in Part II of this report.

Potential Benefits of Audit. We estimated that the DoD could avoid as much as $803 million in procurement, military personnel, and operation and maintenance costs over the 6-year Future Years Defense Plan by reducing duplication and proliferation of models and simulations by establishing guidance and standards for development and by strengthening internal controls (Appendix G).

Summary of Recommendations. We recommended that the Under Secretary of Defense for Acquisition develop policies and responsibilities related to investment, internal development, interoperability standards, modification of existing assets, and maintenance of catalogues; that DoD Components develop policy, guidance, standards, and criteria by which verification, validation, and accreditation of models and simulations is to be accomplished; and the Under Secretary of Defense for Acquisition establish a DoD-wide configuration management and documentation policy for models and simulations.

Management Comments. The Under Secretary of Defense for Acquisition concurred with all recommendations. The Joint Staff stated that the subject audit provides an excellent assessment of the status of DoD policy and guidance for modeling and simulation standards and verification, validation, and accreditation. The Department of the Army fundamentally agreed with the general thrust of the audit report. The Department of the Navy did not formally respond but informally agreed with our recommendations. The Naval War College concurred with all recommendations but suggested that the threshold reporting criteria in Recommendation A.2. be lowered. The Department of the Air Force did not respond.

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This report was prepared by the Acquisition Management Directorate, Office of the Assistant Inspector General for Auditing, DoD. Copies of the report can be obtained from the information officer, Audit Planning and Technical Support Directorate, (703) 614-6303 (DSN 224-6303).

PART I - INTRODUCTION

Background

A "model" is a physical, mathematical, or otherwise logical representation of a system, entity, phenomenon, or process. A "simulation" is a method for implementing a model over time, as well as a technique for testing, analysis, or training in which real world and conceptual systems are reproduced by a model. "Simulation" is also defined as a model of a "real world" situation. The terms "model" and "simulation" are often used interchangeably. Design of a model starts with assumptions representing this "real world" situation as a mathematical model (equations), list of events, or a combination of equations and events.

In DoD, models and simulations are used to study and analyze various scenarios and threats in a combat environment. Military Departments and Defense agencies have a hierarchy of models for this purpose that are generally oriented to their primary mission.

Expanding technological capability has enabled operations researchers to apply computer-assisted analysis to more diverse fields of study in an increasingly sophisticated manner. This has resulted in a significant increase in the number and frequency of use of modeling within the DoD.

Accordingly, DoD management and Congress have become concerned about the potential for duplication and proliferation of modeling and simulation. In June 1991, the Deputy Secretary of Defense established the Defense Modeling and Simulation Office (DMSO). This initiative also assigned responsibility for modeling in DoD to the Under Secretary of Defense for Acquisition, created the DoD Executive Council for Models and Simulations (EXCIMS), and addressed the need for interoperability standards and protocols.

In March 1992, the Joint Staff established the Joint Simulation and Interoperability Division. Objectives for this Joint Staff initiative included promoting the application of modeling and simulation in joint operational planning and execution, education, training, exercises, operations requirements, joint test and evaluation, and doctrine development and evaluation. This initiative is to promote the introduction of new modeling and simulation technology into joint operational use and to assist the Force Structure, Resources, and Assessment Directorate, J-8, to consolidate the modeling and simulation plans of the commanders in chief, cut costs, and reduce duplication.

Objectives

Our objective was to determine if redundant investment is being made by DoD for modeling and simulation efforts supporting weapon system development. In addition, we evaluated internal controls used to prevent unnecessary investment in modeling.

Scope

The audit was performed from December 1991 through August 1992. We visited 24 activities and evaluated 62 models and simulations randomly selected by statistical sampling. We reviewed and analyzed system documentation; configuration management plans and controls; and evidence of verification, validation, and accreditation for each model and simulation in our sample. We also obtained actual expenditures for the most recent 5-year history and budget estimates for expenditures for the upcoming 5-year period at each activity visited. In addition, we evaluated internal controls and organizational relationships related to this technical area.

This economy, efficiency, and program audit was performed in accordance with auditing standards issued by the Comptroller General of the United States as implemented by the Inspector General, DoD, and accordingly included such tests of internal controls as were considered necessary. Appendix H lists activities visited or contacted during the audit.

In August 1990, BDM/ITAC Corporation, under contract to the Deputy Director for Defense Research and Engineering, submitted to DoD a compendium of models and simulations existing within the Department. This BDM/ITAC compendium was not represented as a comprehensive listing, but rather sought to establish a baseline for future development and management of modeling and simulation to support Operational Test and Evaluation (OT&E).

The BDM/ITAC compendium identified 500 models and simulations categorized into 13 mission areas defined as either a generic application or major weapon system application. We limited our audit scope to the 341 models or simulations within the compendium that were owned or controlled by DoD. Our approach used this population from which we selected 62 models for analysis and review.

Science Applications International Corporation (SAIC) and the Quantitative Methods Division of the IG, DoD, provided technical assistance for analysis of model documentation; configuration management; and verification, validation, and accreditation (VV&A). The Quantitative Methods Division of the IG, DoD, also assisted in sample selection and in projecting sample results.

Internal Controls

We evaluated the effectiveness of internal controls established to prevent redundant or unnecessary investment in models and simulations. The audit identified material internal control weaknesses as defined by Public Law 97-255, Office of Management and Budget Circular A-123, and DoD Directive 5010.38. Controls either were not in place or were generally ineffective at most activities visited during the audit. In addition, many activities visited were not in compliance with applicable DoD regulations. All recommendations cited in this report, if implemented, will correct these weaknesses. A copy of this report will be provided to the senior official responsible for internal controls within the Office of the Under Secretary of Defense for Acquisition.

Prior Audits and Other Reviews

The General Accounting Office; Inspector General, DoD; and U.S. Army Audit Agency have issued four reports on modeling and simulation from December 1987 through July 1991.

U.S. Army Audit Agency Report No. 91-A1, "Development of Computer-Based Models and Simulations," July 1991. The auditors prepared an advisory report with suggested actions and management checklists to assist managers and model and simulation developers. The Deputy Under Secretary of the Army (Operations Research) endorsed this advisory report stating, "The advisory report furnishes a sound basis for managing model and simulation development by all levels of management." The report concluded that policies and procedures were needed to ensure that models and simulations were properly managed, justified, approved, and controlled. Specific recommended actions include requiring new model and simulation development efforts to conform to DoD and Department of the Army documentation standards, requiring proper verification and validation efforts be documented before new models and simulations are accredited for use in Army applications, and requiring revalidation of models and simulations each time changes are made.

Appendix F summarizes other reports issued on modeling and simulation.

Other Matters of Interest

Numerous inquiries and studies have been conducted on computer-assisted representations of warfare in DoD which include:

- Defense Science Board Task Force on Computer Applications to Training and Wargaming (1988),

- Defense Science Board Task Force on Improving Test and Evaluation Effectiveness (1989), and

- DoD Simulation Policy Study (1990).

All three studies concluded that there were managerial and technical deficiencies in implementing computer technology to the analysis of warfare in the DoD. Specific managerial deficiencies included modeling and simulation users and developers lacking a broad DoD perspective, Services and commands pursuing courses of action that often led to a lack of interoperability between simulations, and a lack of configuration management.

Technical problems included the need to improve VV&A processes and procedures; the need for common architectures, standards, and interoperability; and the need for research and development.

In a report entitled "A Review of Study Panel Recommendations for Defense Modeling and Simulation," June 1992, and completed for the DMSO, the Institute for Defense Analyses summarized 179 recommendations made by senior study panels over a 16-year period concerning Defense modeling and simulation. Certain common themes permeate all of these recommendations.

Specifically the reports recommended that the responsibility for modeling and simulation should be raised to senior levels of the Services and Joint Staff; Defense management should provide policy to guide greater cooperation and information sharing on development, implementation, maintenance, verification, validation, and accreditation of Defense models and simulations; and the need for a broadened perspective as to how and where modeling and simulation technology should be applied. Other common themes included the need for systematic planning, improving technology, improving technical quality, and increasing applications in system acquisition and test and evaluation.

Another matter of interest is Army Regulation 5-11, "Army Model and Simulation Management Program," July 10, 1992. This regulation establishes the Army Model and Simulation Management Program (AMSMP) and prescribes policies and responsibilities for the management of modeling and simulation used for all purposes within the Army. It also provides a management structure and regulatory guidance governing the development, acquisition, and use of modeling and simulation in specific functional disciplines. These functional disciplines include research and development, test and evaluation, education and training, production and logistics, and analysis.

The AMSMP establishes the Army Model and Simulation Executive Council and the Army Model and Simulation Management Office. The Army Model and Simulation Executive Council is to act as a study advisory group and to recommend policy guidance to the Deputy Under Secretary of the Army (Operations Research) concerning the management of all Army modeling and simulation.

The Army Model and Simulation Management Office (AMSMO) is to act as executive secretariat for the Army Model and Simulation Executive Council, establish and maintain a catalogue of Army models and simulations, and act as focal point for Army matters in dealing with the DMSO.

Army Regulation 5-11 specifically requires:

- Development of an Army Model Improvement Master Plan, which is to include specific management procedures and processes for administration of the Army Model Improvement Program.

- Assignment of responsibility to the AMSMO to develop and maintain an automated Model and Simulation Master Catalogue. In addition, it establishes the AMSMO as a single point-of-contact for input into Defense cataloguing systems.

- Verification, validation, and accreditation of all models and simulations developed after the effective date of the regulation.

- Configuration management to be applied to any model or simulation developed wholly or partly with Army funding.

- Use of standardized, non-redundant data structures for input and output data for models and simulations developed after the effective date of the regulation.

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PART II - FINDINGS AND RECOMMENDATIONS

A. DUPLICATION, REDUNDANCY, AND PROLIFERATION

Model and simulation projects are being procured and developed within the DoD without adequate coordination and control. This situation is occurring because DoD has not established policy, procedures, or guidance to manage and coordinate Defense modeling and simulation activities. This situation has resulted in redundant models and simulations and proliferation of system architectures and libraries. During this audit, we estimated that only a 10-percent reduction in the number of redundant models and simulations represents as much as $803 million of unjustified funds over the 6-year Future Years Defense Plan.

DISCUSSION OF DETAILS

Background

When the Deputy Secretary of Defense approved creation of the DMSO on June 21, 1991, he stated that the new office was intended to support the Undersecretary of Defense for Acquisition "in strengthening the use of modeling and simulation in joint education and training, research and development, test and evaluation, and operations and cost analysis."

Properly applied, modeling and simulation can generate useful information quickly and relatively inexpensively when compared to the cost of conducting actual field exercises and multiple live fire tests of major weapons systems. Modeling can be used to represent scenarios, threats, direct engagement counterfire, electronic warfare interaction, and a combat environment on a scale impractical in the "real world." Modeling can also be used in the conceptual design of a developing weapon system as a simple input-output black box or as a functional representation of the weapon system.

Different funding sources make it difficult to identify precisely the resources within DoD dedicated to modeling and simulation. In 1991 the Deputy Director of Defense Research and Engineering (Plans and Resources) estimated that DoD would spend as much as $939 million in FY 1992 on modeling and simulation supporting weapon system development.

As part of our audit, we attempted to verify this estimate. At 24 activities visited, we identified and collected data on FY 1992 expenditures directly related to the development and use of computer modeling. Using this data, we estimated that these 24 activities will spend as much as $198 million on modeling and simulation for FY 1992.

Based on cost data from these activities and extrapolating from the BDM/ITAC Corporation sample data, we estimate that during FY 1992, DoD expenditures for modeling and simulation supporting weapon system development could be as much as $1.3 billion to $1.6 billion (Appendix A).

DoD Management of Modeling and Simulation Activities

Within DoD much work on various projects related to modeling and simulation has generated a multitude of computer codes, with different designs and language implementation, but frequently oriented toward the same goal. Technological advances now allow users to solve problems and share information to an extent not formerly possible.

Historically, computer models have been developed within Components to address specific mission-related issues and questions. Only in the last 5 years has the need for a DoD perspective regarding the management of modeling and simulation been recognized.

DoD Components are aware of the need for modeling and simulation standards and protocols and are attempting to solve this problem at the Component level. The lack of guidance from the Office of the Secretary of Defense (OSD) level has resulted in standardization efforts that are not coordinated and controlled.

During our review, we were unable to identify any formal OSD level direction, guidance, or policy statements regarding management of or investment in computer modeling. Guidance for the consistent development of modeling and simulation plans by DoD Components has not been furnished. Two positive steps we did note were the issuance of the Deputy Secretary of Defense memorandum, dated June 21, 1991, "Modeling and Simulation Management Plan" and the Under Secretary of Defense for Acquisition memorandum dated July 22, 1991, which established the Defense Modeling and Simulation Office.

Subsequent to establishment of the Defense Modeling and Simulation Office, two draft initiatives have been issued that would provide these requisite DoD policies and assign responsibilities for the management of these endeavors. Specifically, Draft DoD Directive 50XX.XX, "Modeling and Simulation," August 1992, if approved, would establish DoD policies and assign roles and responsibilities for the management of modeling and simulation. The USD(A) would be responsible for strengthening the use of modeling and simulation within DoD and for issuing plans, policies, directives, procedures, and publications for management and advancing modeling and simulation.

In March 1992, the Joint Staff prepared a draft of Chairman, Joint Chiefs of Staff, Memorandum of Policy No. 68, "Management of Joint Modeling and Simulation." If approved, this memorandum would establish policy and procedures and assign responsibilities for the management of joint modeling and simulation activities and would create a Joint Modeling and Simulations Panel.

Internal Controls Related to Modeling and Simulation Investments

Internal management controls are those policies, procedures, and practices established to ensure that DoD Components manage resources effectively and efficiently. Effective internal controls that would prevent or minimize duplication and proliferation in modeling and simulation activities would include comprehensive inventories, standardized procedures for approving new development or modifications, and accounting procedures to track costs.

Audit Sample. At the 24 locations visited, we evaluated existing internal management controls of modeling activities. We also reviewed policies and procedures for approving development of new models and simulations and the modifications made to existing models. In addition, we reviewed inventories, lists, compendiums, or catalogues and examined available cost information.

Policies and Procedures for New Development or Modifications. We found that policies and procedures for approving acquisition or development of a new model or modification to an existing model vary extensively throughout DoD. Models developed or modified "in-house" are subjected to a rigorous review and approval process at some locations but have virtually no formal review or approval process at others. This variation is evident even when the activities are in the same Service. Specific examples of policies and procedures in place at three Department of the Air Force activities are as follows:

- The Air Force Wargaming Center, Maxwell Air Force Base, Alabama, has a formal, documented approval process for in-house development of models and simulations. Written requests for development or modification are submitted to the Systems Directorate. The Directorate Chief has approval authority for projects estimated not to exceed 2 staff-years effort. Projects that exceed this threshold are forwarded to Air University Command for approval.

- The Air Force Electronic Warfare Center, San Antonio, Texas, has a less formal approval process. A director assigned a project or study will determine if development or modification of an existing model or simulation is necessary. If so, the director then

determines if this development or modification can be done in-house. If the director decides to do the work in-house, the necessary engineers, programmers or analysts will be tasked to complete the project.

o The Air Force Studies and Analysis Agency, Pentagon, Washington, D.C., has no formal policies or procedures for approving or tracking in-house modifications. Analysts performing the study or analysis make whatever changes they deem necessary to complete their assignment.

Inventories of Models and Simulations. The likelihood that unnecessary development of new computer models will take place is increased if DoD, the Military Departments, and Defense agencies do not maintain an accurate inventory of existing model and simulation assets and their respective capabilities. Several activities visited during our audit were unable to provide us with an accurate inventory.

The U.S. Army Missile Command (MICOM), Huntsville, Alabama, provided the audit team with a list of models that did not include any of the five models on the BDM/ITAC compendium, from which our sample was drawn. However, subsequent discussion with MICOM personnel disclosed that the Command either had been or was currently using all five of these models. A MICOM official stated that because of the decentralized management structure, he doubted if anyone knew how many models were in use at the activity.

Similarly, The U.S. Army Aviation and Troop Command, Saint Louis, Missouri, initially reported only three computer models in its inventory. Subsequent discussions with various Command sources resulted in the audit team being given a list of more than 100 models and simulations currently in use at the Command.

Modeling and Simulation Costs. One of the first steps in effectively managing expenditures is to accurately identify both current and prior spending. At 22 of the activities visited, the cost of a model or simulation developed by a Government contractor was readily identifiable. However, the Defense Advanced Research Projects Agency and the Army Strategic Defense Command contended that costs associated with modeling and simulation were so embedded in various analyses, studies, or development contracts that it would be nearly impossible to extract the costs incurred for the portions involved in modeling.

Duplication and Proliferation of Models and Simulations

The completed BDM/ITAC compendium was provided to us as being the most comprehensive list of models and simulations supporting weapon system development within DoD. We

selected our statistical sample from the BDM/ITAC compendium, which listed 500 models and simulations, identified by mission issue area. Of these 500 models and simulations, 159 were owned or access-controlled by non-DoD interests. From the remaining 341 models owned or controlled by DoD, we randomly selected our statistical sample of 62 models.

The BDM/ITAC compendium categorized these models and simulations into "mission issue areas" whose dimensions or functional characteristics could involve common algorithms or data or both. Many of these computer models had functional characteristics that were defined by two or more "mission issue areas." Specifically, of the 341 models owned or controlled by DoD:

- 87 (26 percent) had a Space component,
- 86 (25 percent) had an Electronic Warfare component,
- 79 (23 percent) had a C3I component,
- 67 (20 percent) had an Air-to-Air component,
- 43 (13 percent) had a Force-on-Force scenario,
- 42 (12 percent) had a Global scenario, and
- 40 (12 percent) had an Air-Land component.

During the audit we continued to collect lists, compendiums, catalogues, and libraries with additional computer models related to weapon system development. Eliminating duplications on lists obtained from different sources, we identified an additional 1,400 unique models or simulations available for direct or indirect support of weapon system development. DoD and its Components owned or controlled an additional 1,208 of these models or simulations beyond those identified in the BDM/ITAC compendium.

Using criteria set in a list of Technical Questions (Appendix B), the audit team's technical experts identified duplicate and redundant models. These models were developed to analyze mission effectiveness, electronic warfare mission planning, aircraft penetration, deployment of communications equipment, transportation and logistics, and strategic defense (Appendix C). As with the "mission issue areas" of the BDM/ITAC compendium, many models and simulations included in our sample had characteristics that could be categorized into two or more functional areas. Specifically, of the 62 models and simulations sampled:

- 34 (55 percent) had measures of system effectiveness,
- 26 (42 percent) had a Many-on-Many scenario,
- 25 (40 percent) had measures of system performance,
- 24 (39 percent) had an Air-to-Air scenario, and
- 21 (34 percent) had Electronic Warfare/Electronic Countermeasures components.

These suggest the possibility of overlap in function or data and represent duplication and proliferation in development of these computer models.

The BDM/ITAC compendium was intended to be a representative inventory of models and simulations available to DoD in Fiscal Year 1988 for Operational Test and Evaluation purposes. By March 1992, only 14 of the 62 models originally selected from the compendium in our random sample were still in active use. Assuming this same ratio of active to inactive computer models for the entire BDM/ITAC compendium and assuming this can be extended to the compendium prepared by the audit team, any given model or simulation has a relatively short "useful life."

This has two implications. First, significant effort is devoted to developing new "stand-alone" models throughout DoD. Second, since little effort is directed at reusing all or parts of existing models, prior investment is essentially lost. Constantly developing new models without attempting to reuse existing ones results in costly duplication of effort.

Recently a joint program was established to develop a standard modeling architecture and simulation support system for development and analysis of validated digital threat models. The Joint Modeling and Simulation System (J-MASS) program has efforts underway to use parts of existing models and simulations as appropriate and to develop reusable code and data.

Proliferation of System Architectures

The term "architecture" in the context of modeling and simulation refers to information formats (syntax), information content (semantics), and physical connections which join one model or simulation to another. Any architectural relationship must have at least the first two attributes, i.e., some information format and content. For purposes of our audit, we are defining "architecture" as a collection of interface standards, a common language, and a conceptual framework for modeling and simulation issues.

The broad and diverse uses of models and simulations within DoD require that overall architectural standards be established to allow interoperability of models and simulations, thereby increasing the sharing of resources among DoD Components.

We identified a number of system architectures in various development stages. Most of these architectures are widely accepted within their respective user communities. However, at the DoD level, these projects are not visible. Because there are no interface standards, we feel these system

architectures under development are unlikely to be interoperable with other architectures or systems. Accordingly, because there are no interface standards, this ongoing investment in development of system architectures probably will not be productive since it will not result in interoperability.

Modeling and Simulation Libraries

We observed an unnecessary proliferation of modeling and simulation catalogues throughout DoD. Many DoD Components are commissioning or publishing catalogues and lists of models and simulations that are limited in scope. Information contained in these catalogues varies greatly because there is no DoD standard or guidance as to what information should be included.

The most comprehensive list of models we identified was the "Catalog of Wargaming and Military Simulation Models," 12th Edition, published by the Joint Staff, Force Structure, Resource and Assessment Directorate (J-8). This list contains 522 distinct models and simulations.

During our audit, we identified more than 1,900 distinct models and simulations listed in 30 individual catalogues or listings. Our analysis indicates that more than 700 were listed in multiple catalogues. We also found that many DoD Components were developing and using models or simulations not listed in any catalogue or reference source.

Absence of a central library resource, standardized listings, and a mandatory reporting requirement contributes to redundant investment because users have no reliable way to determine what models or simulations already exist that might satisfy their immediate requirement.

DMSO has initiated the Modeling and Simulation Information System as a prototype electronic bulletin board and repository. The Modeling and Simulation Information System will have clearinghouse capabilities to include; a directory of modeling and simulation catalogues, and lists of significant events and documents. Full operational capability is expected to be achieved in June 1993.

Potential Monetary Benefits

At 24 activities visited, we identified and collected data on actual and budgeted expenditures for FY 1992 directly related to modeling and simulation activities. This cost data included funding for operations and maintenance, military personnel, procurement, and research, development, test and evaluation. We then summarized the funding data to determine an aggregate cost for modeling and simulation at

each activity visited. Based on cost data from these activities and extrapolating from the BDM/ITAC Corporation sample data, we estimate that during FY 1992, DoD expenditures for modeling and simulation supporting weapon system development could be as much as $1.3 billion to $1.6 billion (Appendix A).

Our technical assistants estimate that a 10-percent reduction in modeling effort can reasonably be achieved through elimination of unnecessary redundancy. This reduction represents as much as $803 million (10 percent X $1.338 billion X 6 years) of unjustified funds over the 6-year Future Years Defense Plan.

Conclusions

Historically within DoD, models and simulations have been developed in response to a specific question or problem. Only rarely have these ad hoc models or simulations been extended to general solutions with an approach to a wider context. An important aspect of utilization is the application of a model or simulation developed for one particular use to another, possibly quite different, use. The ability to use a given model across many applications offers significant benefits by reducing development effort.

The absence of interoperability standards at the OSD level promotes duplication and proliferation of computer models. As these models and simulations cannot effectively interface, it is difficult to use them for analysis related to joint operations. There is currently a joint effort between DMSO and the Defense Advanced Research Projects Agency (DARPA) to develop and implement the Aggregate Level System Protocol (ALSP). ALSP would allow Service-developed wargames to communicate and interoperate. On two major exercises the ALSP has been successfully demonstrated.

There are inadequate internal controls relative to modeling and simulation activities in the Military Departments and Defense agencies. Effective policies, procedures, and guidelines to control investment in modeling and simulation have not been established.

Complete inventories of models and simulations and their respective capabilities are known only within an individual mission area. There is no single authoritative library that users and developers of models can access to determine if an existing asset could satisfy a perceived need.

Draft DoD Directive 50XX.XX does not establish a permanent OSD level management and administrative structure to direct and control modeling and simulation activities throughout

the DoD. Responsibility for overseeing development of DoD policies, directives, procedures, and interoperability standards and protocols is assigned to the EXCIMS. The EXCIMS is required to meet only twice each calendar year.

RECOMMENDATIONS FOR CORRECTIVE ACTION

We recommend that the Under Secretary of Defense for Acquisition:

1. Assign responsibility for development of policies and procedures related to investment, internal development, interoperability standards, modification of existing assets, and maintenance of catalogues regarding modeling and simulation activities within DoD. Army Regulation 5-11 could provide the baseline for development of these DoD procedures.

2. Develop a standard reporting procedure for starting new modeling and simulation efforts with a cost threshold exceeding $50,000 for input into a DoD-wide catalogue system and require all Components to comply with this procedure.

3. Require that DoD Components establish formal oversight responsibilities and associated internal controls for modeling and simulation activities, based on Army Regulation 5-11, "Army Model and Simulation Management Program."

4. Establish and maintain a common DoD modeling and simulation library with ready access to modeling and simulation users and developers.

MANAGEMENT COMMENTS AND AUDIT RESPONSES

The Director of Defense Research and Engineering responded for the Under Secretary of Defense for Acquisition and indicated that the audit report was a timely assessment of modeling and simulation efforts within the Department. However, the Director of Defense Research and Engineering feels that the report did not fully acknowledge the Department's plans and efforts to rectify these deficiencies. The Director of Defense Research and Engineering concurred with Recommendations A.1., A.2., A.3., and A.4. provided the audit report include a statement that corrective action is in process.

Audit Response. We consider the comments from the Director of Defense Research and Engineering to be responsive. We agree that a number of initiatives have been undertaken by the Department to address issues raised in our audit report. We also agree that when implemented the Draft DoD Directive 50XX.XX, "Modeling and Simulation," should assist in improving DoD management of modeling and

simulation activities. We have revised the report to give recognition to specific efforts and initiatives begun by the EXCIMS, DMSO, and others that seek to remedy problems identified during the course of our audit.

The Joint Staff stated that the subject audit provides an excellent assessment of the status of DoD policy and guidance in the area of modeling and simulations standards.

The Department of the Army fundamentally agreed with the general thrust of the audit report and generally concurred with the recommendations as they address the need for integrated policies at the DoD level. However, the Army feels that the report contained substantive errors and misuses in terminology that detracted from its overall credibility. Specifically, the Army felt the report did not recognize the ongoing nature of activities making incremental advances toward resolving essentially technical issues; the baseline sample used in the audit was not reliable, complete, or current; and the draft report uses the term "operations research assets" as a synonym for "modeling and simulation."

Audit Response. The Army's response implies that models are for the modelers and that DoD management should trust that the modelers are the appropriate ones to address the issues raised in our audit. We believe this viewpoint fails to consider the broad range of applications for modeling and simulation across the entire management spectrum of the Department.

The Department of Defense and the Military Services use modeling and simulation to analyze a wide range of problems and reasonably expect plausible solutions to be developed from these analyses. Decisionmakers who use modeling and simulation analyses are unlikely to be "professional model developers" and, accordingly, they would be unfamiliar with terms, assumptions, and limitations of the "modeling and simulation community." Even though decisions that used these analyses are often significant and important, no disclosures are required or are typically made by model developers regarding the appropriateness or accuracy of modeling and simulation in these analyses.

Accordingly, we believe that decisions based on flawed analyses (due to improper application of a model or the use of a model with an algorithm that is inherently flawed) can be worse than decisions based on educated guesses and intuition. In the former case, we tend to ascribe an aura of "science" to the decision; in the latter case, we understand the "educated guess" element.

We realized that the baseline sample used in the audit was not reliable, complete, or current and started the audit with the knowledge that no single, authoritative list of models and simulations exists within DoD. This was done because one of our main audit objectives was to illustrate this lack of visibility at the DoD level and to demonstrate the lack of management control over the DoD modeling and simulation effort. Accordingly, our approach was to use a relatively clean and up-to-date list to direct us to organizations that do use models for weapons system development. Audit site visits uncovered significant numbers of additional models and helped identify those models no longer in use. Since we did not use this sample to project audit results statistically, the fact that the sample was incomplete and unreliable is material only to further illustrate our point that DoD needs to improve management controls in modeling and simulation.

References in the draft audit report labelled "operations research assets" have been changed to read "modeling and simulation" in accordance with generally accepted DoD usage.

The Department of the Navy did not formally respond. However, informally the Navy agreed there is a need for centralized direction and control of model and simulation policy. In addition, the Navy has started to identify duplicative models; to establish an inventory of current models; and to establish a master plan and an investment plan.

The Naval War College concurred with all recommendations to control procurement and development of models and simulations. To provide a greater degree of assets reporting, however, the Naval War College suggested that the reporting threshold criteria be lowered from the recommended $500,000.

Audit Response. In our draft report we had recommended a cost threshold of $500,000 for input into a DoD-wide catalogue system. The Naval War College suggested that the reporting threshold criteria be lowered from the recommended $500,000. After reviewing draft report comments, we agree and have modified our recommendation to lower the reporting threshold to $50,000.

The Department of the Air Force did not respond.

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B. VERIFICATION, VALIDATION, AND ACCREDITATION

The vast majority of models and simulations currently used in DoD have not been verified, validated, or accredited. This occurred because DoD does not have a requirement, criterion, or standard by which to accomplish a verification, validation, or accreditation process. As a result, weapon system requirements, procurement decisions, engineering designs, test and evaluation results, and operations may be based on data that is inaccurate or misleading. Also users' lack of confidence in models and simulations that are not verified, validated, or accredited encourages duplication and proliferation.

DISCUSSION OF DETAILS

Background

Verification is the process of determining whether a model or simulation accurately represents the developer's conceptual description and specifications. Elements of verification include determination of the model's logic and code and an assessment of documentation and code versus a standard.

Validation is the process of determining the degree to which a model or simulation is an accurate representation of the "real world" from the perspective of the intended uses of the model. Elements of validation include face validation (expert opinion), input data validation (intelligence), and output data validation (testing and sensitivity analysis).

Accreditation is an official determination that a model or simulation is acceptable for a specific purpose. Elements of accreditation include determining if the model was assessed under the conditions of the analysis and how much validation is adequate for it to be used in a particular application.

DoD does not require that models and simulations be verified, validated, or accredited. Although the Army has defined VV&A in its Army Regulation 5-11, at the OSD level, as well as other Military Departments and Defense agencies, there are no accepted definitions for these terms; and there are no criteria or standards by which VV&A should be accomplished. The Navy and Air Force have not developed a requirement, criterion, or standard by which VV&A should be accomplished.

Audit Sample Results

At the 24 locations visited, our technical experts evaluated 62 models for VV&A (Appendix D). Only three models in this sample (5 percent) had completed a formal VV&A process. Comparison studies or an informal VV&A process had been accomplished on 33 models; the remaining 26 models (42 percent) had no VV&A.

For comparative purposes, we evaluated an additional sample of 26 of the more recently developed models and found that they too had not received formal VV&A. We concluded that there had been no significant increase in the number of recently developed models that had completed a formal VV&A. We attribute this lack of improvement in recently developed models to the absence of a DoD requirement for VV&A.

Decisions Based on Model and Simulation Data

Output data from models and simulations is frequently used in the DoD decisionmaking process to define weapon system requirements, influence procurement decisions, aid in engineering design, determine test and evaluation results, and perform operations analyses. Our audit results indicate that as many as 95 percent of the models used for these purposes have not been fully verified, validated, or accredited. Accordingly, there is considerable risk to users that output data might be inaccurate and, therefore, lead to costly mistakes and delays.

Verification, Validation, and Accreditation Not Required by DoD

Models and simulations within the DoD have been developed by Components addressing specific mission-related issues and questions. Models used for these purposes typically had no visibility at the OSD level.

Recent advances in computer technology allow computer modelers to address issues and share information to an extent that was formerly not possible. These advances have expanded areas appropriate for the application of modeling/simulation into military operations, production and logistics, research and development, and test and evaluation.

We were unable to identify any formal OSD-level direction, guidance, criteria, or standards regarding VV&A of models and simulations, although many DoD Components have realized the need for VV&A and have initiated efforts to accomplish VV&A at the Component level. These efforts have been frustrated due to the lack of a VV&A requirement and the absence of OSD-level criteria and guidance. Recent

recognition of the pervasive use of modeling and simulation throughout the DoD for all types of analyses have given impetus to the need for a DoD perspective regarding management of this activity, in general, and the need for VV&A of models and simulations, in particular.

Most major acquisition programs use modeling to verify one or more aspects of system performance. If a program fails to meet performance goals, it is difficult to identify any single element as the primary cause. The use of models and simulations that have not been verified, validated, or accredited is suspected of contributing to some performance failures. Specifically, the use of inaccurate and incorrect modeling and simulation data for decisions has contributed to significant problems in DoD. For example, the B-1B Bombers' defective Defensive Avionics System was developed with models that were not verified, validated, and accredited. The Advanced Medium Range Air-to-Air Missile development also utilized a model that was not verified, validated, and accredited. Serious trajectory problems had to be corrected. Also, before the Transportation Model (TRANSMO) was verified, validated, and accredited in August 1991, it contained erroneous input data. The result was a significant overestimate of deployment capability for Operations Desert Shield/Storm.

B-1B Bomber. The AN/ALQ-161 Defensive Avionics Suite in the Air Force B-1B Bomber was designed to detect, identify, and classify hostile radar threats and automatically direct appropriate jamming responses against these threats in a descending order of priority. Our review found that models and simulations that were not verified, validated, or accredited were used in development and testing of the AN/ALQ-161.

The prime contractor on the B-1B program developed a model to determine the probability of the B-1B's survival in a nuclear war. Output data from this model was influential in arriving at major program decisions.

A major subcontractor on the B-1B, who developed the AN/ALQ-161 Defensive Avionics Suite, used simulations in designing the system. We were unable to obtain any records documenting VV&A. Also, personnel familiar with the B-1B program that we interviewed did not recall efforts being made by the subcontractor for VV&A of the models and simulations. As a result, the simulations ultimately did not model high-power threats existing on test ranges.

Specifically, when the AN/ALQ-161 Defensive Avionics Suite was flight-tested, the "real" test operating environment overpowered the system. The system could identify the top ten threats in a low-threat environment but would be overwhelmed in a high-threat environment.

On June 17, 1992, the Air Force disclosed that it would cost an estimated $1.1 billion to correct, enhance, and support the B-1B Defensive Avionics Suite.

AIM-120 AMRAAM Missile. The Advanced Medium Range Air-to-Air Missile (AMRAAM) is a joint Air Force and Navy program to develop a medium-range, radar-guided missile to be used in air-to-air combat against enemy aircraft. The AMRAAM is designed to be compatible with the latest fighter aircraft, including the F-14, F-15, F-16, F/A-18, and the Advanced Tactical Fighter.

The AMRAAM missile test plan provides for a combination of simulation tests, flight tests, and live missile firings. Simulations were conducted before live missile firings to predict actual missile performance and examine other scenarios otherwise too dangerous or costly to perform or both. The AMRAAM-Installed System Performance Reliability (ISPR) is a weapon system performance model used to support Operational Test and Evaluation (OT&E) of the AMRAAM missile.

One function of AMRAAM-ISPR is to simulate an AMRAAM missile six-degree-of-motion trajectory after launch. Before 1988, earlier versions of this model that had not been verified, validated, or accredited were used for OT&E purposes. Subsequently, when live missile firing test results were analyzed, the results indicated serious problems with the six-degree-of-motion trajectory after launch.

The six-degree-of-motion trajectory after launch problem had not been detected by simulations run before live firing tests. We believe that a model subjected to a rigorous VV&A process would have provided data with a greater degree of reliability and accuracy and might have detected this trajectory problem before conducting live firing tests.

In 1988, a later version of the AMRAAM-ISPR model was validated but not verified or accredited. Nevertheless, data provided by these models has been used by the Defense Acquisition Board to support decisions made regarding the AMRAAM program. In addition, because the trajectory problem was not detected until after live firing tests were conducted, AMRAAM missile software had to be modified to correct the problem.

TRANSMO. The Transportation Model is a time-oriented, event-stepped simulation of inter-theater deployment activities based on availability of transportation assets and prioritized requirements for deployment. The model computes arrival schedules for units and resupply cargo. The TRANSMO was not formally accredited and was not verified

and validated until August 1991 when data collected during Operations Desert Shield/Storm (ODS) was used to compare TRANSMO-predicted results to ODS actual results.

Specifically, for cargo delivered by sea, the simulated deployment was in error by 84 percent; for cargo delivered by air, the simulated deployment error increased to 178 percent. Overall, the TRANSMO simulation underestimated the total cargo time to a Middle-East theater of operations by 114 percent.

Deployment capability estimates by TRANSMO were significantly overestimated because of optimistic planning data which contained inaccurate scenario assumptions and planning factors. If the TRANSMO simulation had been subjected to a rigorous VV&A process before ODS, inaccurate input data could have been reviewed and corrections could have been made, resulting in a greater degree of reliability.

Compounding of Errors

It is important to note that data outputs from one model or simulation are frequently used as data inputs to a second or perhaps even a third model or simulation in a chain-linked series. Accordingly, if erroneous output data is used from a model or simulation lacking VV&A, errors are likely in all subsequent analyses.

Confidence Placed in Modeling/Simulation Data

Even though a given model/simulation has not been subjected to a rigorous VV&A process, analyses performed by these models frequently assume a significant role in DoD decision-making. A specific case is a model named "Survivability by Computer Analysis" (SCAN). It models performance of the missile warhead's proximity fuze, fragmentation of the missile warhead, and target damage caused by individual warhead fragments. SCAN produces a probability of target kill by tracing the paths of warhead fragments through the target.

Although we were told that lethality analysts have informally verified SCAN code against actual fuze software and design documents, we could not obtain documentation to support any comparisons between results obtained with the SCAN model and actual missile flight tests. Despite this lack of VV&A, SCAN has been used to support operational evaluations of the AIM-120 (AMRAAM), the AIM-7 (SPARROW), the AIM-9 (SIDEWINDER), the AIM-54 (PHOENIX), and the PATRIOT missiles.

In 1991, a major Defense contractor requested a copy of SCAN to use on modeling of air-to-ground hardened target penetrators for design and concept proposals and the Army requested a copy of SCAN to use in vulnerability modeling of two amphibious alternatives for the Bradley fighting vehicle. In addition, SCAN has also been used for battle damage and repair studies for F-16 and C-130 aircraft.

Users have placed confidence in the SCAN analyses related to research, development, and test and evaluation of major weapon system programs even though the veracity of these analyses has not been demonstrated. As a result, the Defense Acquisition Board and other acquisition officials may have based significant acquisition decisions on analyses generated by a model that has not been verified, validated, or accredited.

Conclusions

Data generated by models and simulations are used in analyses to support decisions of significant value and importance. However, model developers and users have not been performing VV&A because there was no DoD requirement or standard by which VV&A was to be done. In addition, the absence of DoD criteria resulted in VV&A having low priority and inadequate justification for expenditure of funds and allocation of resources.

Audit results indicate 95 percent of models and simulations used in DoD have not been subjected to a formal VV&A process. Using these models can result in erroneous and misleading data being introduced to the decisionmaking process. In the case of major weapon system development programs, this may lead to large additional expenditures to correct errors introduced by using inaccurate data.

A DoD requirement for VV&A of models and simulations can eliminate or reduce errors in computer modeling data that is used by DoD personnel in the decisionmaking process. The VV&A process adds assurance and confidence that accurate input data is used in models that will contribute to the prevention of costly and time-consuming mistakes.

Draft DoD Directive 50XX.XX assigns DoD Components the responsibility for development of VV&A policies and procedures for modeling and simulation applications managed by the Component. It also assigns to the Component the responsibility for the accreditation of modeling and simulation applications used to support major DoD decisionmaking, such as the Defense Acquisition Board, Joint Requirements Oversight Council, and the Defense Planning and Resources Board. Nowhere in this directive is the role of the Defense Intelligence Agency addressed with respect to the VV&A of threat forces and capabilities in models and

simulations. In addition, we feel that the policy, guidance, standards, and criteria by which VV&A is to be accomplished should be established at the OSD level for the guidance and direction of DoD Components.

RECOMMENDATIONS FOR CORRECTIVE ACTION

We recommend that the Under Secretary of Defense for Acquisition:

1. Using the Army Model and Simulation Management Program as a framework, develop policy, guidance, standards, and criteria by which verification, validation, and accreditation of models and simulations is to be accomplished.

2. Require that models and simulations used for requirements definition, weapon system development, engineering, and testing and evaluation be verified, validated, and accredited in accordance with policy, guidance, standards, and criteria of Recommendation 1.

MANAGEMENT COMMENTS AND AUDIT RESPONSES

The Director of Defense Research and Engineering, responding for the Under Secretary of Defense for Acquisition, concurred with Recommendations B.1. and B.2., provided the audit report include a statement that corrective action is in process. The Director of Defense Research and Engineering (DDR&E) noted that the Draft DoD Directive 50XX.XX, "Modeling and Simulation," establishes requirements for verification, validation, and accreditation of models and simulations. The Director also noted, however, that it would be very costly to prescribe an enforceable single VV&A standard and that DDR&E feels that the VV&A process needs to be defined by the individual DoD component.

Audit Response. We consider the comments from the Director of Defense Research and Engineering to be generally responsive. However, we still believe that a single VV&A standard needs to be defined at the OSD level. We feel that there are many instances where general use modeling and simulation applications may be used to support major DoD decisionmaking organizations and processes such as the Defense Planning and Resources Board; the Defense Acquisition Board; the Joint Requirements Oversight Council; and the DoD Planning, Programming, and Budgeting system.

Draft DoD Directive 50XX.XX assigns management responsibility for these general use models and simulations to a DoD Component designated as the "DoD Modeling and Simulation Executive Agent" for that general use

application. The policies and procedures used to VV&A that general use model or simulation would be the ones established by that respective DoD Component. Therefore, unless a single minimum standard for VV&A is established at the OSD level, each respective general use model or simulation used to support these major DoD decisionmaking organizations may have been verified, validated, and accredited by different standards. Accordingly, we request that the Director of Defense Research and Engineering reconsider his position when responding to the final report.

The Joint Staff stated that the subject audit provides an excellent assessment of the status of DoD policy and guidance for modeling and simulation verification, validation, and accreditation.

The Department of the Army indicated that the definitions of verification, validation, and accreditation and the methods used to apply them to models and simulations are much debated topics within the community. The lack of a specific DoD mandate was not the reason that developers do not seem to do an adequate job in this area. The Army felt quite the contrary, that there is much serious discussion and debate about what constitutes adequate verification, validation, and accreditation and how and when to apply the various techniques that are available.

Audit Response. The response by the Army indicates a situation where those responding may have too narrow a view of where, when, and how models are being applied within DoD. Our point is that most people who use models in the Department see only how they themselves use them; they fail to understand the broad range of applications for models across the entire management spectrum of the Department.

We realize that there is much serious discussion and debate about what constitutes adequate verification, validation, and accreditation and how and when to apply the various techniques that are available. However, after more than 40 years, there is still no agreement in the "professional modeling and simulation community" as to a generally accepted definition of verification, validation, and accreditation or how it should be accomplished.

Currently, the weaknesses and limitations of specific models and simulations are known just by a handful of "modeling and simulation professionals." The proposed verification, validation, and accreditation requirement will help ensure that the strengths, weaknesses, and limitations of models and simulations will be disclosed up front, to the decisionmakers.

The Department of the Navy did not formally respond. However, informally the Navy agreed there is a need for centralized policy direction related to verification, validation, and accreditation. In addition, the Navy has started to develop instructions and procedures related to the verification, validation, and accreditation of models and simulations.

The Naval War College concurred with all recommendations to establish plans, policies, and procedures relative to verification, validation, and accreditation of models and simulations.

The Department of the Air Force did not respond.

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C. CONFIGURATION MANAGEMENT AND DOCUMENTATION

The majority of models and simulations used in DoD lack adequate configuration management and documentation necessary to assure readily available access by authorized Defense personnel. This condition exists because of ineffective guidance and lack of oversight by Department of Defense Components. As a result, users and developers of models and simulations are unwilling or unable to use existing computer models, which can result in added costs to modify present models and simulations or develop new ones.

DISCUSSION OF DETAILS

Background

Configuration management, as defined by DMSO, is "The application of technical and administrative direction and surveillance to identify and document the functional and physical characteristics of a model, control changes, and record and report change processing and implementation status."

Documentation refers to items such as programmer's manuals, user's manuals, analyst's manuals, and other media that assist or instruct the user in the operation or maintenance of a model/simulation.

Inadequate Configuration Management and Documentation

We found that agency-wide configuration management and documentation of models and simulations were usually nonexistent or requirements were not enforced. Several activities had inconsistent results even at the same location.

Specifically, some models and simulations reviewed had adequate configuration management and were well-documented while others had no configuration management or documentation. At one Air Force activity, we reviewed six models and found that two models had good configuration management programs and another two models were well-documented. However, of the six models/simulations reviewed, none had both adequate configuration management and good documentation.

Similarly, review of two models in use at a Navy test facility found that one had adequate configuration management and was completely documented, while the other model reviewed had no elements of an effective configuration management program and had no documentation. Similar situations were also found at Army activities (Appendix E).

Discussions with model developers and users at these locations disclosed that the lack of a clear requirement or guidance from DoD or the Component headquarters caused this situation. Accordingly, configuration management policy and the degree of required documentation for models and simulations is being determined by each model developer on a model-by-model basis.

Configuration Management

Changes to coding of a model could have adverse effects on model performance. Configuration management of models and simulations is important because only by managing changes to models/simulations that have been verified, validated, and accredited will potential users be assured that a model or simulation will perform as intended. Effective configuration management includes the planning, documenting, and reporting of any changes or modifications and the effect of the change or modification on model performance and use.

Criteria. Three elements are necessary for adequate configuration management. Specifically, these elements are:

- o Configuration management policy which establishes the administrative process for approving and documenting changes to the model or simulation;

- o Configuration management plans that describe how changes to the existing model or simulation will be accomplished; and

- o Configuration management board or official with prior approval authority for all proposed changes to the model or simulation.

Audit Sample Results. We reviewed 62 models and simulations during our audit for adequacy of configuration management. We found that only 16 (26 percent) of these had adequate configuration management control procedures in place. While 35 models or simulations had some formal or informal configuration management, 27 (44 percent) of those reviewed had none of the essential elements in place for effective configuration management (Appendix E).

At several activities, we noted that models and simulations developed "in-house" generally had less formal configuration management control procedures than did models and simulations developed by Government contractors. In addition, more recently developed models and simulations were more likely to have adequate configuration management procedures. Still, only 35 percent of recently developed models and simulations had adequate configuration management versus 22 percent of the earlier ones.

Documentation

Documentation explains how and for what purposes a model or simulation can be used. Inadequate or inaccurate documentation can, therefore, result in a model or simulation being useless to anyone other than the original developer.

Criteria. Military Standard 2167A establishes documentation requirements for software developed for or by the DoD. We believe that, as a minimum, documentation for models and simulations should consist of a user's manual, analyst's manuals, and programmer's manuals.

Audit Sample Results. We reviewed available documentation for the 62 models or simulations in our sample and found that only 8 (13 percent) had adequate documentation based on this criteria. Of the remaining 54 models, 20 had two of the three required documents. One of the three required documents was available for 14 models. However, 20 models (32 percent) had no documentation (Appendix E).

While our analysis indicates that more recently developed models and simulations have a higher percentage of minimally acceptable documentation (14 percent versus 12 percent), this difference is considered statistically insignificant.

As with configuration management, we noted that computer models developed "in-house" are much less likely to be well-documented than those developed for the Government by contractors. The reason most often cited for this disparity is that in-house developers do not expect their models to be used by others. In-house developers do not usually conform to the DoD Standard 2167A requirements for documentation.

Current Initiatives

There have been several recent efforts undertaken to address modeling and simulation standards related to documentation and configuration management. Specifically, these include the Aggregate Level Simulation Protocol (ALSP), the Distributed Interactive Simulation (DIS), and the Defense Simulation Internet (DSI). ALSP was started in 1990 by the Defense Advanced Research Projects Agency (DARPA) to design an interface for multiple combat simulations. It is currently chartered by USD(A) through the EXCIMS. ALSP is developing field interface protocols and supports an integrated multi-function training environment for joint and combined exercises through configuration management of ALSP protocols and system software, and deployment of tools and documentation.

DIS is an effort to develop a common standard for describing the form and types of messages to be exchanged between simulated entities. DIS is another DARPA effort sponsored by the DMSO. The Institute of Electrical and Electronic Engineers (IEEE) have issued this common standard as IEEE Draft Standard P1278.

DSI is intended to be a high performance, wide area, packet switched network to support the infrastructure for a DoD seamless warfighting simulation. The Defense Information Systems Agency (DISA) and DARPA, with support from the DMSO are developing DIS. The configuration management controls and standardization embodied by the ALSP, DIS, and DSI initiatives will enable DoD Components to utilize modeling and simulation in support of training, acquisition, and mission support at significantly less cost than that required for separate simulations.

Conclusion

Analysis of sample data and discussions with developers and users of models and simulations indicate that DoD management controls regarding configuration management and documentation are inadequate. Our audit sample results indicated that only 26 percent of the models/simulations reviewed had adequate configuration management control procedures in place. Although most models/simulations in the sample had some form of documentation, few had sufficient documentation to make the model reasonably accessible to potential users.

Documentation and configuration management control procedures that are inadequate lead to costly duplication of effort. Potential users may feel that developing a new model or simulation is less risky than attempting to use an existing one that is inadequately documented.

RECOMMENDATIONS FOR CORRECTIVE ACTION

We recommend that the Under Secretary of Defense for Acquisition:

1. Establish a DoD-wide policy requiring configuration management plans for all future development of models and simulations.

2. Establish a DoD-wide policy requiring adequate documentation for all future development of models and simulations.

MANAGEMENT COMMENTS AND AUDIT RESPONSES

The Director of Defense Research and Engineering, responding for the Under Secretary of Defense for Acquisition, concurred with Recommendations C.1. and C.2., provided the audit report include a statement that corrective action is in process. The Director of Defense Research and Engineering states that implementation of Draft DoD Directive 50XX.XX, "Modeling and Simulation," includes the designation of a configuration management proponent in each modeling and simulation application.

The Director of Defense Research and Engineering also notes that Draft DoD Directive 50XX.XX, "Modeling and Simulation," has specific documentation requirements including development of a master plan and an investment plan.

Audit Response. We consider the comments from the Director of Defense Research and Engineering to be responsive. We agree that a number of initiatives have been undertaken by the Department to address issues raised in our audit report. We also agree that when implemented the Draft DoD Directive 50XX.XX, "Modeling and Simulation," should assist in improving configuration management and documentation of DoD modeling and simulation activities.

The Joint Staff did not comment on this finding and recommendation.

The Department of the Army stated that lack of configuration management of models and simulations and inadequate documentation were difficult problems that "have been with us a long time."

Audit Response. While Army concurs with the condition and effect of the finding, they see the cause not as a lack of criteria or DoD Directives but as a long-term problem on which incremental advances are being made. The Army further states that "bureaucratic fiat will not resolve the issues involved." This appears to contradict Army Regulation 5-11, "Army Model and Simulation Management Program," July 10, 1992. This Army Regulation requires that configuration management be applied to any model or simulation developed wholly or partly with Army funding. We see a DoD requirement as a means to end incremental advances and stop a 40-plus-year debate in the "modeling and simulation community."

The Department of the Navy did not comment on this finding and recommendation.

The Naval War College concurred with all recommendations to establish policies, plans, and procedures to effectively institute configuration management and to obtain documentation.

The Department of the Air Force did not respond.

PART III - ADDITIONAL INFORMATION

The following acronyms are used in this report.

AMC ..... Army Materiel Command
ARDEC ... Armament Research, Development, and Engineering Center, Army
DASCP .. Directorate for Advanced Systems, Concepts, and Planning
DCAA ..... Defense Contract Audit Agency
DFARS ..... Defense Federal Acquisition Regulation Supplement
DoE ..... Department of Energy
FAR ..... Federal Acquisition Regulation
FFRDC ..... Federally Funded Research and Development Center
GAO ..... General Accounting Office
JPL ..... Jet Propulsion Laboratory
MICOM ..... Missile Command, Army
MPRI ..... Military Professional Resources, Incorporated
NASA ..... National Aeronautics and Space Administration
NRO ..... NASA Resident Office
OIG ..... Office of the Inspector General
TACOM ..... Tank-Automotive Command, Army
TVA ..... Tennessee Valley Authority

APPENDIX A: ESTIMATED DoD MODELING AND SIMULATION EXPENDITURES FOR FY 1992

Different funding sources make it difficult to precisely identify total DoD expenditures related to modeling and simulation efforts supporting weapon system development. Therefore, our objective was to obtain order of magnitude computations related to the cost of 1,549 models identified as being owned and controlled by DoD and its Components.

The following estimates of expenditures are based on extrapolation of data we collected during the audit. These estimates are not based on the statistical sample and, accordingly, are not statistical estimates. Rather they represent the best indicators presently available of DoD expenditures related to modeling and simulation for FY 1992.

Our analyses used two approaches based on expenditures required to operate the 24 activities visited during the audit. The Average Cost per Model/Simulation approach used an average cost per model or simulation, weighted by activity and service. The Proportioned Cost of Activities Using Modeling/Simulation approach used a ratio of activities on which we had cost data compared to total activities identified in the compendium assembled by the audit team.

Specifically, for FY 1992 the Average Cost per Model/Simulation approach estimates total DoD expenditures at $1.58 billion. The Proportioned Cost of Activities Using Modeling/Simulation approach estimates total DoD expenditures at $1.338 billion.

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APPENDIX B: MODEL/SIMULATION TECHNICAL QUESTIONS

GENERAL QUESTIONS REGARDING EACH MODEL/SIMULATION

1. What is the name of the model/simulation?
2. What kind of model is it, e.g., Air Defense, 1-on-1, M-on-N?
3. Is this a single model or a collection of models?
4. Who owns (controls access to) the model?
5. Who is the point-of-contact for information regarding the model?
6. When was the model first operational?
7. Is the model currently in use on a regular basis?
8. Is the model a stand-alone model or does it work with other models?
    - 8.1. If it can work with other models, to what degree (e.g., are they interactive or do you just get output data and then use that data as input to a separate run of another model)?
    - 8.2. What are the models that work with your model?
    - 8.3. When was it done and the name of a point-of-contact to be used to obtain information regarding that model?
    - 8.4. If it works with other models, is there an interface standards document?
    - 8.5. What does the model or simulation require for input and what is the source of this input?
9. How many times is it necessary to run the model to get reliable results?
    - 9.1. How was that number derived?
    - 9.2. Is there a standard that was used to derive the necessary number of runs?

APPENDIX B: MODEL/SIMULATION TECHNICAL QUESTIONS
(Continued)

10. In developing (or updating) the model, what efforts were made to obtain tri-Service requirements?

    10.1. What efforts were made to obtain intra-Service requirements?

    10.2. What efforts were made to obtain requirements from anyone outside of your immediate organization?

11. In developing the model, what efforts were made to use existing algorithms?

    11.1. Did the algorithms exist?

    11.2. Where did you look for these algorithms?

    11.3. In what form were the algorithms (documentation); did you use them?

12. What is the run time of the model?

13. What does the model simulate (for what purpose is it used)?

    13.1. What is the end use for the model's output?

    13.2. Has this model been modified as the threat has changed?

    13.3. Has threat data been validated by the Defense Intelligence Agency?

    13.4. Is there a weapons system in the development or acquisition cycle that this model/simulation is being used for? If so, identify this weapons system?

APPENDIX B: MODEL/SIMULATION TECHNICAL QUESTIONS
(Continued)

QUESTIONS REGARDING DEVELOPMENT OF EACH MODEL/SIMULATION

14. When was the model developed?

    14.1. Who developed it?

    14.2. How much did it cost?

    14.3. Why was it developed?

    14.4. Can it support any major acquisition decision?

    14.5. Was it ever used to support a major acquisition decision? Is there documentation to support a "yes" answer?

    14.6. Did it ever support any decisions? Are they documented?

15. How long did it take to develop the model?

16. Is any part of the model proprietary (model, parts of the model, source code, documentation)?

    16.1. How much will it cost to buy the rights (including documentation and source code)?

17. What programming standards were used in the development of the model and/or the updates?

18. In what language(s) is the model written?

    18.1. Is there a version-specific language used?

    18.2. Why was the language used and was this decision documented?

    18.3. Was Ada considered; was a waiver sought and the decision documented?

    18.4. How big is the program (lines of code and disk space)?

APPENDIX B: MODEL/SIMULATION TECHNICAL QUESTIONS
(Continued)

QUESTIONS REGARDING SPECIFIC CHARACTERISTICS OF EACH MODEL/SIMULATION

19. How is the model distributed?

    19.1. Type media?

    19.2. Documentation?

    19.3. Update notification?

20. On what computer is the model presently running?

    20.1. What is the domain of platforms (what are the platforms the model can run on; is the model touted as "machine independent" or close to it for a class of computer platforms)?

21. What operating system is required to support the model?

    21.1. Is a specific version required?

    21.2. What libraries are required for the model to run (e.g., a specific graphics or utility library of programs)?

    21.3. Are special commercial licenses required?

22. If a new user desires to use the model, what hardware and software are required?

    22.1. Is anything else required?

    22.2. How does the user know that your model exists and what its capabilities and limitations are?

    22.3. How does the user get the model and what documentation comes with it?

    22.4. Is formal training available?

    22.5. What is the total cost to the user for the model?

23. Does the model run in real time (can it)?

    23.1. If the model is not a real time model, what are its performance characteristics (usually in X times real time, e.g., the model may run 10 to 1 or the model takes 10 seconds to represent 1 second of real time; high fidelity models can be 5000 to 1)?

24. What fidelity is the model (how many levels are there)?

    24.1. How do you define that fidelity level?

    24.2. What distinguishes this fidelity level from any other?

    24.3. Can the model run at more than fidelity level?

    24.4. Can the model interact with another model at the same fidelity level?

    24.5. Can the model interact with another model at a different fidelity level?

25. Can the user of the model choose the scenario for the simulation?

    25.1. How much can the user deviate from the "classic" scenario?

26. Does the model include some type of warning that it is not good for certain scenarios?

    26.1. Are there restrictions on its use for those scenarios?

27. Does the model specifically state how it should be used?

    27.1. Does it state how it should not be used?

28. Does the model have a post processing capability?

    28.1. What is produced by the model (data, graphics, both)?

APPENDIX B: MODEL/SIMULATION TECHNICAL QUESTIONS
(Continued)

29. Can you start, pause, and restart the simulation?

30. What type of operator interaction is involved?

    30.1. Do you start the model and simply play back the results?

    30.2. Is the model interactive (man-in-the-loop)?

31. Can you compare two or more runs to analyze the difference in results?

32. Is the simulation graphical (do you see pictorially what's going on)?

33. What is the annual operations and maintenance cost for the model (dollars and people)?

QUESTIONS REGARDING DOCUMENTATION AND CONFIGURATION MANAGEMENT OF EACH MODEL/SIMULATION

34. What type of documentation exists?

    34.1. User guides?

    34.2. Programmer's guide?

    34.3. MIL-STD-2167A documentation?

        34.3.1. Software Development Plan?

        34.3.2. Software Requirements Document?

        34.3.3. System Segment Specification?

        34.3.4. Interface Requirements Specification?

        34.3.5. Software Design Document?

        34.3.6. Test Plans, etc.?

35. Is there a configuration management plan?

- 35.1. Who maintains configuration management?
- 35.2. How do changes/upgrades get documented?
- 35.3. How often are updates made?
  - 35.3.1. Who decides?
  - 35.3.2. What is the update criteria?
  - 35.3.3. How are tri-Service users involved?
  - 35.3.4. How is it funded?
  - 35.3.5. Who does the work?
    - 35.3.5.1. How long does it take to do the update?
    - 35.3.5.2. If contracted, how often do the updates get competed?

QUESTIONS REGARDING VERIFICATION, VALIDATION, AND ACCREDITATION OF EACH MODEL/SIMULATION

36. Was the model ever validated?

- 36.1. What definition of validation was used? (This is especially important to establish that many different views exist on what is and is not validation. Bottom Line: The generally accepted definition for model validation says that "Validation is the process of determining the degree to which a model is an accurate representation of the real world from the perspective of the intended use of the model."
- 36.2. How was validation conducted (by Component or for the overall system)?

36.3. Who validated it (Who did the analyses to determine the model represented the real world)?

36.4. What documentation exists to support a validation decision (Are the analyses documented in some fashion)?

36.5. What validation criteria were used (What were the items used in the analyses; what were the measures of merit for these items)?

36.6. Who developed the validation criteria?

36.7. Who decided the validation criteria were correct?

36.8. Who signed-off on the overall validation for this model?

36.9. If the model represents a foreign system, who certified that the information and the representation of that information (algorithms) were correct? Are they the responsible DoD office for that system (read DIA for threat type systems)?

37. Was the model ever accredited for any particular program (Did someone say that the model was appropriate to use for a specific test or project)?

37.1. Who made the accreditation?

37.2. What authority did they have to make the accreditation?

37.3. Is there any documentation to support the accreditation decision?

37.4. What was the criteria used in the accreditation process?

37.5. How were the criteria developed?

37.6. Who developed the criteria?

37.7. Who decided the criteria were acceptable?

APPENDIX B: MODEL/SIMULATION TECHNICAL QUESTIONS
(Continued)

38. Have the results of the model been compared to other models?

    38.1. Did they compare?

        38.1.1. If not, why?

        38.1.2. What didn't compare favorably?

        38.1.3. Was your model correct?

        38.1.4. Was the other model correct?

        38.1.5. Were both models incorrect?

39. Were the results ever compared to the real world?

40. Are the results repeatable?

    40.1. Was repeatability tested?

    40.2. Was it re-tested after the model was changed (updated)?

    40.3. Who performed the testing?

    40.4. Is the testing documented?

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APPENDIX C: MODEL NAME VERSUS FUNCTIONAL AREA SAMPLE RESULTS

ACRONYMS AND ABBREVIATIONS FOR MODEL FUNCTIONAL AREAS

m-on-m	Scenario with arbitrary number of players or items, such as m "blue" war game players against n "red" war game players, with an arbitrary number of communication nodes or arbitrary number of interacting weapon systems.
1-on-1	Scenario with two opposing simulation players or items. Most often a friendly weapon system posed against a threat weapon system.
Strat.	Strategic weapon systems included as part of the simulation scenario. Nuclear, biological, and chemical weapon systems were counted as strategic weapon systems.
C2	Command and Control.
C3I	Command, Control, Communications, and Intelligence.
Log./Trans.	Logistics and/or Transportation simulation. Any simulation concerned with the supply, storage, or transportation of materials on a large scale.
EW	Electronic Warfare. Infrared sensor systems have been included as electronic warfare systems.
ECM	Electronic Countermeasures.
Syst. Perf.	System Performance Simulation. Any simulation that includes the behavior or operational characteristics of a weapon system or weapon systems.
Syst. Effec.	System Effectiveness Simulation. Any simulation that models the ability of a weapon system or weapon systems to accomplish a task or achieve a goal.
Surv.	Survivability.
Vuln.	Vulnerability.
Leth.	Lethality.

APPENDIX C: MODEL NAME VERSUS FUNCTIONAL AREA SAMPLE RESULTS (Continued)

Model Name/ (Audit Site)	Functional Area																
	m-on-m	1-on-1	War Game	Strat.	C2/ CJI	Log./ Trans.	Air	Land	Sea	Under-Sea	Space	EW/ ECM	Syst. Perf.	Syst. Effec.	Surv.	Vuln.	Leth.
ADAM														X			
AEM	X		X	X													
ALBM					X		X	X									
ALV								X					X				
AMRAAM-ISPR		X					X						X				
APM	X		X				X										
ARTOAR		X					X						X	X			X
ASPM					X			X					X	X			
BUILDUP						X	X	X	X								
CAAM	X								X	X			X				
CASTFOREM	X		X														
CEOPS	X		X														
CISCAID	X						X										
COMJ1.BAS												X		X			
COMJAM												X		X			

APPENDIX C: MODEL NAME VERSUS FUNCTIONAL AREA SAMPLE RESULTS (Continued)

Model Name/ (Audit Site)	Functional Area																
	m-on-m	1-on-1	War Game	Strat.	C2/ C3I	Log./ Trans.	Air	Land	Sea	Under-Sea	Space	EW/ ECM	Syst. Perf.	Syst. Effec.	Surv.	Vuln.	Leth.
COVART II								X								X	
CRASOF	X					X	X	X	X								
DETCONT														X			
ENGAGE	X		X				X										
EPLRS	X				X								X	X			
FASTSTICK	X		X				X										
FDM	X													X			
FLAGGING													X	X			
FORCEM	X		X		X		X	X									
FRAM	X		X				X		X								
FROBAK	X		X	X													
GEMACS							X	X				X	X	X		X	
GSM									X	X			X	X			
HOME							X					X	X	X			
HPMWAM		X						X					X	X			

APPENDIX C: MODEL NAME VERSUS FUNCTIONAL AREA SAMPLE RESULTS (Continued)

Model Name/ (Audit Site)	Functional Area																
	m-on-m	1-on-1	War Game	Strat.	C2/ C3I	Log./ Trans.	Air	Land	Sea	Under-Sea	Space	EW/ ECM	Syst. Perf.	Syst. Effec.	Surv.	Vuln.	Leth.
IEW												X		X			
IMOM	X											X					
IRSS													X	X			
JAWS	X		X	X	X				X	X							
J/S.V01												X		X			
J/SCIR.V01												X		X			
LTM	X													X	X		
MSS ETESIM	X				X						X	X	X	X			
NAS												X	X	X			
NORSE	X			X										X			
OSPREY	X		X								X						
P001		X					X						X	X	X		X
RADGUNS		X					X					X	X	X	X		X
RECCE												X	X				
RESA	X		X		X		X		X	X		X					

APPENDIX C: MODEL NAME VERSUS FUNCTIONAL AREA SAMPLE RESULTS (Continued)

Model Name/ (Audit Site)	Functional Area																
	m-on-m	1-on-1	War Game	Strat.	C2/ C3I	Log./ Trans.	Air	Land	Sea	Under-Sea	Space	EW/ ECM	Syst. Perf.	Syst. Effec.	Surv.	Vuln.	Leth.
SAB	X		X				X		X								
SATPROP											X	X		X	X		
SCAN		X					X						X	X			X
SIGDAT				X							X	X	X				
SIM II	X		X					X		X	X						
SIMSTAR					X									X			
SLAVE													X	X	X	X	X
SODSIM	X			X										X			
SPACECEM											X	X	X	X			
SPAN					X									X			
SPIRITS												X	X	X			
STRAPEM	X		X				X					X					
TAPM		X					X								X	X	
TEAM		X										X	X	X			
TEM		X					X					X		X			

APPENDIX C: MODEL NAME VERSUS FUNCTIONAL AREA SAMPLE RESULTS (Continued)

	Functional Area															
Model Name/ (Audit Site)	m-on-m	1-on-1	War Game	Strat.	C2/ C3I	Log./ Trans.	Air	Land	Under-Sea	Space	EW/ ECM	Syst. Perf.	Syst. Effec.	Surv.	Vuln.	Leth.
TRANSMO	X					X	X	X	X							
TSP	X						X				X	X	X			

APPENDIX D: VERIFICATION, VALIDATION, AND ACCREDITATION SAMPLE RESULTS

	Verification	Validation	Accreditation
Office of the Secretary of Defense			
Defense Advanced Research Projects Agency			
ALBM: Air Land Battle Management	0	0	0
ALV: Autonomous Land Vehicle	0	0	0
Strategic Defense Initiative Organization			
SODSIM: Strategic Offense/Defense Simulation	3	3	3
Survivability and Vulnerability Information Analysis Center			
COVART II: Computation of Vulnerable Area			
and Repair Time	3	1	1
P001: Anti-Aircraft Artillery Simulation			
Program P001	2	1	0

0 - None 1 - Informal Efforts 2 - Comparison Studies 3 - Formal Efforts

APPENDIX D: VERIFICATION, VALIDATION, AND ACCREDITATION SAMPLE RESULTS (Continued)

	Verification	Validation	Accreditation
Office of the Chairman of The Joint Chiefs of Staff			
Commander in Chief, Military Airlift Command			
CRASOF: Combat Rescue and Special Operations			
Forces Model	0	0	0
The Joint Staff, Office of the Director			
for Logistics (J-4)			
BUILDUP:	Not Applicable	Not Applicable	Not Applicable
The Joint Staff, Office of the Director			
for Force Structure, Resources and Assessment (J-8)			
JAWS: Joint Analytic Warfare Systems	Not Applicable	Not Applicable	Not Applicable
Department of the Army			
Army Aviation Systems Command			
ARTOAR: Attack Helicopter Air-to-Air			
Fire Control Simulation	1	0	1

0 - None 1 - Informal Efforts 2 - Comparison Studies 3 - Formal Efforts

APPENDIX D: VERIFICATION, VALIDATION, AND ACCREDITATION SAMPLE RESULTS (Continued)

	Verification	Validation	Accreditation
Department of the Army (Continued)			
Army Communications and Electronics Command			
ASPM: Advanced Field Artillery Tactical			
Data System Performance Model	0	0	0
EPLRS: Enhanced Position and Location			
Reporting System	0	0	0
Army Laboratory Command, Harry Diamond Laboratory			
HPMWAM: High Power Microwave Weapon			
Assessment Model	0	0	0

0 - None 1 - Informal Efforts 2 - Comparison Studies 3 - Formal Efforts

APPENDIX D: VERIFICATION, VALIDATION, AND ACCREDITATION SAMPLE RESULTS (Continued)

	Verification	Validation	Accreditation
Department of the Army (Continued)			
Army Laboratory Command, Atmospheric			
Sciences Laboratory			
ADAM: Architecture Development Analysis			
Methodology	0	0	0
CASTFOREM: Combined Arms and Support Task Force			
Evaluation Model	3	3	3
CISCIAD: Combat Identification System/COMO			
Integrated Air Defense Model	1	1	0
DETCONT: Detection Contours	1	1	0
Army Missile Command			
SLAVE: Simple Lethality and Vulnerability			
Estimator	1	2	0

0 - None 1 - Informal Efforts 2 - Comparison Studies 3 - Formal Efforts

APPENDIX D: VERIFICATION, VALIDATION, AND ACCREDITATION SAMPLE RESULTS (Continued)

	Verification	Validation	Accreditation
Department of the Army (Continued)			
Army Strategic Defense Command			
NORSE: Nuclear Optical & Radar System			
Effects Code	1	2	0
Army Concepts Analysis Agency			
FDM: Force Design Model	0	0	0
FORCEM: Force Evaluation Model	2	3	0
TRANSMO: Transportation Model	3	3	1
Army Electronics Proving Ground			
CEOPS: Communication-Electronic Operator			
Positioning System	0	1	0
IEW: Intelligence and Electronic Warfare Model	0	0	0

0 - None 1 - Informal Efforts 2 - Comparison Studies 3 - Formal Efforts

APPENDIX D: VERIFICATION, VALIDATION, AND ACCREDITATION SAMPLE RESULTS (Continued)

	Verification	Validation	Accreditation
Department of the Army (Continued)			
Army Electronics Proving Ground (Continued)			
SPAN: Signal Parametric Analysis of Potential			
Critical Nodes	1	1	0
TEM: Terrain Effects Model	3	3	3
Department of the Navy			
Naval Air Warfare Center, Point Mugu			
AMRAAM-ISPR: Advanced Medium Range Air-to-Air			
Missile Simulation for Installed			
System Performance Responsibility	1	3	1
SCAN: Survivability by Computer Analysis	1	1	1
Naval Command, Control and Ocean Surveillance Center			
RESA: Requirements, Evaluation and			
Systems Analysis	3	1	1

0 - None 1 - Informal Efforts 2 - Comparison Studies 3 - Formal Efforts

APPENDIX D: VERIFICATION, VALIDATION, AND ACCREDITATION SAMPLE RESULTS (Continued)

	Verification	Validation	Accreditation
Department of the Navy (Continued)			
Naval Surface Warfare Center			
FRAM: Fleet Requirements Analysis Model	0	0	0
Naval Undersea Warfare Center			
CAAM: The Composite Area Analysis Model	1	3	0
GSM: Generic Sonar Model	0	0	0
SIM II	3	3	0
Naval War College			
SAB: Surface & Air Battle Seminar Game			
Support Model	0	0	0
Department of the Air Force			
Air Force Studies and Analysis Agency			
AEM: Arsenal Exchange Model	1	1	1
APM: Advanced Penetration Model	0	0	0

0 - None 1 - Informal Efforts 2 - Comparison Studies 3 - Formal Efforts

APPENDIX D: VERIFICATION, VALIDATION, AND ACCREDITATION SAMPLE RESULTS (Continued)

	Verification	Validation	Accreditation
Department of the Air Force (Continued)			
Air Force Studies and Analysis Agency (Continued)			
ENGAGE	0	0	0
FROBACK: Front-end Back-end	1	1	1
STRAPEM: Strategic Penetration Model	1	1	0
TAPM: Tactical Aircraft Penetration Model	0	0	0
Air Force Electronic Warfare Center			
COMJ1.BAS: Communications Jamming			
Effectiveness Graphs	0	0	0
COMJAM: Communications Jamming Model	1	2	0
FLAGGING	3	0	0
HOME: Homing Missile Engagement Model	1	2	0
IMOM: Improved Many-on-Many	1	2	0

0 - None 1 - Informal Efforts 2 - Comparison Studies 3 - Formal Efforts

	Verification	Validation	Accreditation
Department of the Air Force (Continued)			
Air Force Electronic Warfare Center (Continued)			
J/S.V01: J/S Ratio for Communication Jamming	0	0	0
J/SCIR.V01: Communications Jamming Effectiveness Graphs	0	0	0
NAS: Network Communications Analysis System	0	0	0
RECCE	1	1	0
SIGDAT	0	0	0
SATPROP: Satellite-to-Ground Propagation Model	0	0	0
SpaceCEM: Space Communications Effectiveness Model	3	2	0
SPIRITS: Spectral and In-band Radiance Imaging of Targets and Scenes	3	1	0
TEAM: Threat Engagement Analysis Model	1	1	0
TSP: Tactical Sensor Planner	1	2	0

0 - None 1 - Informal Efforts 2 - Comparison Studies 3 - Formal Efforts

APPENDIX D: VERIFICATION, VALIDATION, AND ACCREDITATION SAMPLE RESULTS (Continued)

	Verification	Validation	Accreditation
Department of the Air Force (Continued)			
Air Force Operational Test and Evaluation Center			
LTM: Laser Threat Model	0	0	0
OSPREY: Space Defense Effectiveness Model	0	0	0
RADGUNS: Radar-Directed Gun System Simulations	0	0	0
SIMSTAR(STRATC2AM)	0	0	0
Air Force Wargaming Center			
FAST STICK	1	0	0
Air Force Rome Air Development Center			
GEMACS: General Electromagnetic Model for the Analysis of Complex Systems	1	3	0
IRSS: Interactive Radar Simulator System	2	3	3
MSS ETESIM: Multiple Satellite System End-to-End Simulation	3	1	0

0 - None 1 - Informal Efforts 2 - Comparison Studies 3 - Formal Efforts

APPENDIX E: DOCUMENTATION AND CONFIGURATION MANAGEMENT SAMPLE RESULTS

	Documentation			Configuration Management/ Configuration Control		
	User Manual(s)	Analyst Manual(s)	Programmer Manual(s)	Plan	Policy	Board
Office of the Secretary of Defense						
Defense Advanced Research Projects Agency						
ALBM: Air Land Battle Management				0	0	0
ALV: Autonomous Land Vehicle				0	0	0
Strategic Defense Initiative Organization						
SODSIM: Strategic Offense/Defense Simulation	X	X		1	1	1
Survivability and Vulnerability Information						
Analysis Center						
COVART II: Computation of Vulnerable Area						
and Repair Time	X			1	1	1
P001: Anti-Aircraft Artillery Simulation						
Program P001	X			1	1	1

0 - None
1 - Performed by another activity or by a contractor.
2 - Informal or draft proposal.
3 - Formally implemented at activity.

N/A - Not Applicable

APPENDIX E: DOCUMENTATION AND CONFIGURATION MANAGEMENT SAMPLE RESULTS (Continued)

	Documentation			Configuration Management/ Configuration Control		
	User Manual(s)	Analyst Manual(s)	Programmer Manual(s)	Plan	Policy	Board
Office of the Chairman of the Joint Chiefs of Staff						
Commander in Chief, Military Airlift Command						
CRASOF: Combat Rescue and Special Operations						
Forces Model				0	0	0
The Joint Staff, Office of the Director						
for Logistics (J-4)						
BUILDUP				N/A	N/A	N/A
The Joint Staff, Office of the Director						
for Force Structure, Resources and Assessment (J-8)						
JAWS: Joint Analytic Warfare Systems	X		X	N/A	N/A	N/A

0 - None
1 - Performed by another activity or by a contractor.
2 - Informal or draft proposal.
3 - Formally implemented at activity.

N/A - Not Applicable

APPENDIX E: DOCUMENTATION AND CONFIGURATION MANAGEMENT SAMPLE RESULTS (Continued)

	Documentation			Configuration Management/ Configuration Control		
	User Manual(s)	Analyst Manual(s)	Programmer Manual(s)	Plan	Policy	Board
Department of the Army						
Army Aviation Systems Command						
ARTOAR: Attack Helicopter Air-to-Air Fire						
Control Simulation	X			1	1	1
Army Communications and Electronics Command						
ASPM: Advanced Field Artillery Tactical						
Data System Performance Model		X		0	0	0
EPLRS: Enhanced Position and Location						
Reporting System	X	X		1	1	1
Army Laboratory Command, Harry Diamond Laboratory						
HPMWAM: High-Power Microwave Weapon						
Assessment Model	X			0	0	0

0 - None
1 - Performed by another activity or by a contractor.
2 - Informal or draft proposal.
3 - Formally implemented at activity.

N/A - Not Applicable

APPENDIX E: DOCUMENTATION AND CONFIGURATION MANAGEMENT SAMPLE RESULTS (Continued)

	Documentation			Configuration Management/ Configuration Control		
	User Manual(s)	Analyst Manual(s)	Programmer Manual(s)	Plan	Policy	Board
Department of the Army (Continued)						
Army Laboratory Command, Atmospheric Sciences						
Laboratory						
ADAM: Architecture Development Analysis						
Methodology				0	0	0
CASTFOREM: Combined Arms and Support Task						
Force Evaluation Model	X	X		3	3	3
CISCIAD: Combat Identification System/COMO						
Integrated Air Defense Model	X			0	0	0
DETCONT: Detection Contours	X			0	0	0

0 - None
1 - Performed by another activity or by a contractor.
2 - Informal or draft proposal.
3 - Formally implemented at activity.

N/A - Not Applicable

APPENDIX E: DOCUMENTATION AND CONFIGURATION MANAGEMENT SAMPLE RESULTS (Continued)

	Documentation			Configuration Management/ Configuration Control		
	User Manual(s)	Analyst Manual(s)	Programmer Manual(s)	Plan	Policy	Board
Department of the Army (Continued)						
Army Missile Command						
SLAVE: Simple Lethality and Vulnerability						
Estimator	X	X		2	2	0
Army Strategic Defense Command						
NORSE: Nuclear Optical & Radar System						
Effects Code	X	X		1	1	1
Army Concepts Analysis Agency						
FDM: Force Design Model				0	0	0
FORCEM: Force Evaluation Model	X	X		2	2	2
TRANSMO: Transportation Model	X			0	0	0

0 - None
1 - Performed by another activity or by a contractor.
2 - Informal or draft proposal.
3 - Formally implemented at activity.

N/A - Not Applicable

APPENDIX E: DOCUMENTATION AND CONFIGURATION MANAGEMENT SAMPLE RESULTS (Continued)

	Documentation			Configuration Management/ Configuration Control		
	User Manual(s)	Analyst Manual(s)	Programmer Manual(s)	Plan	Policy	Board
Department of the Army (Continued)						
Army Electronics Proving Ground						
CEOPS: Communication-Electronic Operator						
Positioning System	X	X	X	3	3	2
IEW: Intelligence and Electronic						
Warfare Model	X	X		3	3	0
SPAN: Signal Parametric Analysis of Potential						
Critical Nodes		X		3	3	0
TEM: Terrain Effects Model	X	X	X	1	1	1

0 - None
1 - Performed by another activity or by a contractor.
2 - Informal or draft proposal.
3 - Formally implemented at activity.

N/A - Not Applicable

APPENDIX E: DOCUMENTATION AND CONFIGURATION MANAGEMENT SAMPLE RESULTS (Continued)

	Documentation			Configuration Management/ Configuration Control		
	User Manual(s)	Analyst Manual(s)	Programmer Manual(s)	Plan	Policy	Board
Department of the Navy						
Naval Air Warfare Center, Point Mugu						
AMRAAM-ISPR: Advanced Medium Range Air-to-Air						
Missile Simulation for Installed						
System Performance Responsibility	X	X	X	1	1	1
SCAN: Survivability by Computer Analysis				0	0	0
Naval Command, Control and Ocean Surveillance Center						
RESA: Requirements, Evaluation and Systems						
Analysis	X	X		3	3	2
Naval Surface Warfare Center						
FRAM: Fleet Requirements Analysis Model	X			0	0	0

0 - None
1 - Performed by another activity or by a contractor.
2 - Informal or draft proposal.
3 - Formally implemented at activity.

N/A - Not Applicable

APPENDIX E: DOCUMENTATION AND CONFIGURATION MANAGEMENT SAMPLE RESULTS (Continued)

	Documentation			Configuration Management/ Configuration Control		
	User Manual(s)	Analyst Manual(s)	Programmer Manual(s)	Plan	Policy	Board
Department of the Navy (Continued)						
Naval Undersea Warfare Center						
CAAM: The Composite Area Analysis Model	X	X		0	0	0
GSM: Generic Sonar Model		X		0	0	0
SIM II	X			3	3	3
Naval War College						
SAB: Surface & Air Battle Seminar Game						
Support Model				0	0	2

0 - None
1 - Performed by another activity or by a contractor.
2 - Informal or draft proposal.
3 - Formally implemented at activity.

N/A - Not Applicable

APPENDIX E: DOCUMENTATION AND CONFIGURATION MANAGEMENT SAMPLE RESULTS (Continued)

	Documentation			Configuration Management/ Configuration Control		
	User Manual(s)	Analyst Manual(s)	Programmer Manual(s)	Plan	Policy	Board
Department of the Air Force						
Air Force Studies and Analysis Agency						
AEM: Arsenal Exchange Model	X	X	X	1	1	1
APM: Advanced Penetration Model				0	0	0
ENGAGE	X			0	0	0
FROBACK: Front-end Back-end	X	X		1	1	1
STRAPEM: Strategic Penetration Model	X	X		3	3	0
TAPM: Tactical Aircraft Penetration Model	X	X	X	0	0	0
Air Force Electronic Warfare Center						
COMJ1.BAS: Communications Jamming						
Effectiveness Graphs				0	0	0
COMJAM: Communications Jamming Model	X		X	2	2	0

0 - None
1 - Performed by another activity or by a contractor.
2 - Informal or draft proposal.
3 - Formally implemented at activity.

N/A - Not Applicable

APPENDIX E: DOCUMENTATION AND CONFIGURATION MANAGEMENT SAMPLE RESULTS (Continued)

	Documentation			Configuration Management/ Configuration Control		
	User Manual(s)	Analyst Manual(s)	Programmer Manual(s)	Plan	Policy	Board
Department of the Air Force (Continued)						
Air Force Electronic Warfare Center (Continued)						
FLAGGING				1	1	0
HOME: Homing Missile Engagement Model	X		X	2	2	0
IMOM: Improved Many-on-Many	X		X	3	3	3
J/S.V01: J/S Ratio for Communication Jamming				0	0	0
J/SCIR.V01: Communications Jamming						
Effectiveness Graphs				0	0	0
NAS: Network Communications Analysis System	X			0	0	0
RECCE	X		X	2	2	0
SIGDAT				0	0	0
SATPROP: Satellite-to-Ground Propagation Model	X			0	0	0

0 - None
1 - Performed by another activity or by a contractor.
2 - Informal or draft proposal.
3 - Formally implemented at activity.

N/A - Not Applicable

APPENDIX E: DOCUMENTATION AND CONFIGURATION MANAGEMENT SAMPLE RESULTS (Continued)

	Documentation			Configuration Management/ Configuration Control		
	User Manual(s)	Analyst Manual(s)	Programmer Manual(s)	Plan	Policy	Board
Department of the Air Force (Continued)						
Air Force Electronic Warfare Center (Continued)						
SpaceCEM: Space Communications						
Effectiveness Model	X	X		1	1	0
SPIRITS: Spectral and In-band Radiance						
Imaging of Targets and Scenes	X	X		1	1	0
TEAM: Threat Engagement Analysis Model	X	X		3	3	0
TSP: Tactical Sensor Planner	X		X	3	3	3
Air Force Operational Test and Evaluation Center						
LTM: Laser Threat Model	X	X	X	1	1	0
OSPREY: Space Defense Effectiveness Model	X	X		1	1	0
RADGUNS: Radar-Directed Gun System Simulations	X		X	1	1	0
SIMSTAR(STRATC2AM)	X	X	X	1	1	1

0 - None
1 - Performed by another activity or by a contractor.
2 - Informal or draft proposal.
3 - Formally implemented at activity.

N/A - Not Applicable

APPENDIX E: DOCUMENTATION AND CONFIGURATION MANAGEMENT SAMPLE RESULTS (Continued)

	Documentation			Configuration Management/ Configuration Control		
	User Manual(s)	Analyst Manual(s)	Programmer Manual(s)	Plan	Policy	Board
Department of the Air Force (Continued)						
Air Force Wargaming Center						
FAST STICK	X	X	X	3	3	3
Air Force Rome Air Development Center						
GEMACS: General Electromagnetic Model for the						
Analysis of Complex Systems	X	X		2	2	2
IRSS: Interactive Radar Simulator System	X			0	0	0
MSS ETESIM: Multiple Satellite System						
End-to-End Simulation	X			0	0	0

0 - None
1 - Performed by another activity or by a contractor.
2 - Informal or draft proposal.
3 - Formally implemented at activity.

N/A - Not Applicable

APPENDIX F: PRIOR AUDITS AND STUDIES RELATED TO MODELING AND SIMULATION

GAO Report No. GAO/PEMD-88-3 (OSD Case No. 7336), "DoD Simulations: Improved Assessment Procedures Would Increase the Credibility of Results," December 1987. The GAO considered a framework of 14 factors to evaluate a simulation's credibility. These factors were divided into three major areas of concern: theory, model design, and input data; the correspondence between the model and the real world; and documentation and reporting issues. Evaluating three simulations by collecting and analyzing information using these factors should help identify strengths and weaknesses of a simulation and, therefore, attest to its credibility. The GAO concluded that no guidance existed at the OSD level that could be routinely used throughout DoD to review the credibility of military models. The GAO recommended that the Secretary of the Department of Defense direct agencies responsible for managing three specific weapon systems to correct the limitations GAO had identified during the audit, especially limitations in validation, and adopt or develop and implement guidance on producing, validating, documenting, managing, maintaining, using, and reporting simulations of weapon system effectiveness.

Inspector General, Department of Defense, Report No. 89-057, "Wargaming Activities in the Department of Defense," March 1989. The auditors concluded that DoD Service schools, colleges, and training centers had expanded or planned to expand wargaming capabilities without clear objectives and guidance on joint wargaming activities. In addition, plans to operate and expand computer facilities in support of wargaming for NATO were difficult to justify in view of current operations or future workload. The audit report recommended that the Assistant Secretary of Defense for Force Management and Personnel participate in establishing policies and procedures on wargaming and similar activities; the Joint Chief of Staff designate an office of primary responsibility within the Joint Staff to establish policies and procedures for joint wargaming activities and clarify the mission and responsibilities of DoD colleges, schools, and training centers participating in wargaming activities; discontinue operation and funding of the Joint Warfare Center because its missions and functions overlapped and are duplicated elsewhere; the Navy stop construction of Sensitive Compartmented Information Facilities at Naval schools, colleges, and training centers when wargaming activities are limited to education and training; the Air

Force develop joint program management plans, establish Memorandums of Agreement, and implement operating procedures to manage effectively wargaming activities of the Air Force Wargaming Center. In addition, the audit report recommended that the NATO command prepare an updated management plan specifying objectives of wargaming activities, operating procedures, and the requirement for facilities and computer systems necessary to manage effectively wargaming activities there; and discontinue funding to expand its facilities at the Warrior Preparation Center.

U.S. Army Audit Agency Report No. SW 90-205, "The Army Model Improvement Program," April 1990. The auditors found that additional policies and procedures were needed to ensure that models were properly managed, justified, approved, and controlled; acquisition of general purpose automatic data processing equipment and software was not adequately planned, justified, and approved; the Army's planning, programming, and budgeting system had not been fully implemented; the use of higher order programming languages and configurations of Army models were not adequately controlled; and Corps Battle Simulation Center staffing requirements were frequently not evaluated, justified, and documented. The audit report recommended that the Army establish policies, procedures, and control authority to permit the Army Model Improvement Program Management Office to carry out assigned responsibilities; develop procedures that will result in an overall consolidated information management plan; and improve procedures used to plan, justify, and approve the acquisition of training simulations. In addition, the audit report recommended that an Army-wide configuration control policy be established; Army-wide model documentation standards be established that require independent peer group reviews and approval of model documentation; and to develop a time-phased plan to accredit all Army analytical, functional, and training models and include in the accreditation process verification, validation, documentation, and configuration control charters.

APPENDIX G: SUMMARY OF POTENTIAL BENEFITS RESULTING FROM AUDIT

Recommendation Reference	Description of Benefit	Amount and/or Type of Benefit
A.1.	Economy and Efficiency. Reduce duplication and proliferation of models and simulations.	Funds Put to Better Use. $803 million of unjustified funds over the 6-year Future Years Defense Plan.
A.2.	Internal Control. Assist in avoiding development or procurement of redundant models or simulations.	Contributes to the cost avoidance claimed for Recommendation A.1.
A.3.	Internal Control. Reduce duplication and proliferation of models and simulations in DoD.	Contributes to the cost avoidance claimed for Recommendation A.1.
A.4.	Economy and Efficiency. Avoid unnecessary development and procurement of modeling and simulation assets.	Contributes to the cost avoidance claimed for Recommendation A.1.
B.1.	Internal Control. Ensure that criteria are established to accomplish verification, validation, and accreditation of models and simulations.	Nonmonetary.

APPENDIX G: SUMMARY OF POTENTIAL BENEFITS RESULTING FROM AUDIT (continued)

Recommendation Reference	Description of Benefit	Amount and/or Type of Benefit
B.2.	Internal Control. Ensure that models and simulations used for purposes of requirements definition, weapon systems development, engineering, and testing and evaluation have been properly verified, validated, and accredited.	Undeterminable.
C.1.	Economy and Efficiency. Reduce unnecessary development and procurement of modeling and simulation assets.	Contributes to the cost avoidance claimed for Recommendation A.1.
C.2.	Economy and Efficiency. Reduce duplication and proliferation by ensuring that authorized users of models and simulations have proper documentation necessary to enable this use to occur.	Contributes to the cost avoidance claimed for Recommendation A.1.

APPENDIX H: ACTIVITIES VISITED OR CONTACTED

Office of the Secretary of Defense

Office of the Under Secretary of Defense for Acquisition, Washington, DC
Office of the Director, Defense Research and Engineering, Washington, DC
Office of the Assistant Secretary of Defense (Command, Control, Communications and Intelligence), Washington, DC
Office of the Assistant Secretary of Defense (Program Analysis and Evaluation), Washington, DC
Defense Modeling and Simulation Office, Alexandria, VA

Office of the Chairman of the Joint Chiefs of Staff

Commander in Chief, U.S. Transportation Command, Scott Air Force Base, IL
The Joint Staff, Office of the Director for Operations (J-3), Joint Electronic Warfare Center, San Antonio, TX
The Joint Staff, Office of the Director for Logistics (J-4), Washington, DC
The Joint Staff, Office of the Director for Operational Plans and Interoperability (J-7), Washington, DC
The Joint Staff, Office of the Director for Force Structure, Resources and Assessment (J-8), Washington, DC

Department of the Army

Office of the Chief of Staff of the Army, Test and Evaluation Management Agency, Washington, DC
Office of the Deputy Under Secretary of the Army (Operations Research), Washington, DC
Army Aviation and Troop Command, St. Louis, MO
Army Communications and Electronics Command, Fort Monmouth, NJ
Army Laboratory Command, Atmospheric Sciences Laboratory, White Sands Missile Range, NM
Army Materiel Command, Adelphi, MD
Army Missile Command, Huntsville, AL
Army Strategic Defense Command, Huntsville, AL
Army Training and Doctrine Command, White Sands Missile Range, NM
Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS
Army Concepts Analysis Agency, Bethesda, MD
Army Electronics Proving Ground, Fort Huachuca, AZ

APPENDIX H: ACTIVITIES VISITED OR CONTACTED (continued)

Department of the Navy

Office of the Chief of Naval Operations, Washington, DC
Naval Air Warfare Center, Weapons Division, China Lake, CA
Naval Air Warfare Center, Weapons Division, Point Mugu, CA
Naval Command, Control and Ocean Surveillance Center, Command and Control Interoperability Division, San Diego, CA
Naval Surface Warfare Center, Silver Spring, MD
Naval Undersea Warfare Center, New London, CT
Naval War College, Newport, RI
Marine Corps Wargames Assessment Center, Quantico, VA

Department of the Air Force

Headquarters, U.S. Air Force, Washington, DC
Air Force Studies and Analysis Agency, Washington, DC
Air Force Electronic Warfare Center, San Antonio, TX
Air Force Flight Test Center, Edwards Air Force Base, CA
Air Force Operational Test and Evaluation Center, Kirtland Air Force Base, NM
Air Force Wargaming Center, Maxwell Air Force Base, AL
Rome Laboratories, Griffiss Air Force Base, NY
Wright Laboratories, Wright-Patterson Air Force Base, OH

Defense Agencies

Defense Advanced Research Projects Agency, Arlington, VA
Defense Information Systems Agency, Joint Interoperability and Engineering Organization, Fort Monmouth, NJ
Defense Information Systems Agency, Joint Interoperability and Engineering Organization, Reston, VA
Defense Intelligence Agency, Missile and Space Intelligence Center, Redstone Arsenal, AL
Joint Aircraft Survivability/Vulnerability Information Analysis Center, Wright-Patterson Air Force Base, OH
Strategic Defense Initiative Organization, Washington, DC

APPENDIX I: REPORT DISTRIBUTION

Office of the Secretary of Defense

Under Secretary of Defense for Acquisition
Director, Defense Research and Engineering
Assistant Secretary of Defense (Command, Control, Communications and Intelligence)
Assistant Secretary of Defense (Program Analysis and Evaluation)
Defense Modeling and Simulation Office, Alexandria, VA

Office of the Chairman of the Joint Chiefs of Staff

Commander in Chief, U.S. Transportation Command
The Joint Staff, Office of the Director for Operations (J-3)
The Joint Staff, Office of the Director for Logistics (J-4)
The Joint Staff, Office of the Director for Operational Plans and Interoperability (J-7)
The Joint Staff, Office of the Director for Force Structure, Resources and Assessment (J-8)

Department of the Army

Secretary of the Army
Inspector General, Department of the Army
Office of the Chief of Staff of the Army, Test and Evaluation Management Agency
Office of the Deputy Under Secretary of the Army (Operations Research)
Army Aviation and Troop Command
Army Communications and Electronics Command
Army Laboratory Command, Atmospheric Sciences Laboratory
Army Materiel Command
Army Missile Command
Army Strategic Defense Command
Army Training and Doctrine Command, White Sands Missile Range
Army Corps of Engineers, Waterways Experiment Station
Army Concepts Analysis Agency
Army Electronics Proving Ground

Department of the Navy

Secretary of the Navy
Commandant of the Marine Corps
Assistant Secretary of the Navy (Financial Management)
Office of the Chief of Naval Operations
Naval Air Warfare Center, Weapons Division, China Lake
Naval Air Warfare Center, Weapons Division, Point Mugu
Naval Command, Control and Ocean Surveillance Center, Command and Control Interoperability Division
Naval Surface Warfare Center
Naval Undersea Warfare Center
Naval War College
Marine Corps Wargames Assessment Center

Department of the Air Force

Secretary of the Air Force
Assistant Secretary of the Air Force (Financial Management and Comptroller)
Headquarters, U.S. Air Force
Air Force Studies and Analysis Agency
Air Force Electronic Warfare Center
Air Force Flight Test Center
Air Force Operational Test and Evaluation Center
Air Force Wargaming Center
Rome Laboratories
Wright Laboratories

Other DoD Activities

Director, Defense Advanced Research Projects Agency
Director, Defense Information Systems Agency
Director, Defense Intelligence Agency
Director, Strategic Defense Initiative Organization

APPENDIX I: REPORT DISTRIBUTION (continued)

Non-Defense Activities
Office of Management and Budget
U.S. General Accounting Office, National Security and International Affairs Division, Technical Information Center

Chairman and Ranking Minority Member of the following Congressional Committees and Subcommittees:

Senate Committee on Appropriations
Senate Subcommittee on Defense, Committee on Appropriations
Senate Committee on Armed Services
Senate Committee on Governmental Affairs
House Committee on Appropriations
House Subcommittee on Defense, Committee on Appropriations
House Committee on Armed Services
House Committee on Government Operations
House Subcommittee on Legislation and National Security, Committee on Government Operations

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PART IV - MANAGEMENT COMMENTS

Comments from The Director of Defense Research and Engineering
Comments from The Joint Staff
Comments from the Department of the Army
Comments from the Naval War College

Comments from the Director of Defense Research and Engineering

DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING

WASHINGTON, DC 20301-3010

DEC 10 1993

MEMORANDUM FOR THE DoD INSPECTOR GENERAL

SUBJECT: Draft Audit Report on Duplication/Proliferation of Weapon Systems' Modeling and Simulation Efforts Within DoD (Project No. 2AB-0016)

The DoD IG audit was a very timely assessment of modeling and simulation efforts within the Department. I appreciate the effort that was required to look at this very complex subject. It is important to note that several of your findings mirror similar issues which have been surfaced by the Executive Council on Modeling and Simulation. I concur with the recommendations in the report provided that the corrective action currently underway for each is stated. My main concern is that the report does not fully acknowledge the Department's plans and efforts to rectify the deficiencies. Addressing these plans and efforts sufficiently in the report will help make the report a useful management tool to assist in focusing the issues. My assessment is that the actions we have underway should when complete clear up your concerns.

In June 1991, the USD(A), recognizing the need for better management of modeling and simulation, established the Defense Modeling and Simulation Office (DMSO) as a focal point for policy and integration. The DMSO has been working since that time on the issues you identified. Consequently, a major step in resolving modeling and simulation issues will be the issuance of DoDD 50XX.XX, "Modeling and Simulation." In addition to updating the audit report to reflect the ongoing efforts and the progress made in eliminating the deficiencies, I suggest that the Office of the Inspector General endorse and recommend the expeditious issuance of DoDD 50XX.XX, "Modeling and Simulation."

Comments on the audit report recommendations as prescribed by DoD Directive 7650.3, paragraphs F.b(1) and F.b(2), are provided at Attachment 1. Additional detailed comments on the draft report are at Attachment 2. These detailed comments provide additional information on several items and also correct a number of technical errors. Their inclusion will improve the overall accuracy and completeness of the final report. If we can be of any further assistance in your effort, my point of contact for DMSO is Col. Ed Fitzsimmons, (703) 998-0660.

Victor H. Reis

Attachments

ATTACHMENT 1

Director, Defense Research and Engineering Comments on Audit Recommendations

As prescribed in DoD Directive 7650.3, Section F., paragraphs b(1) and b(2), the following comments are in response to the recommendations made in the DoD Inspector General's "Draft Audit Report on Duplication/Proliferation of Weapons Systems' Modeling and Simulation Efforts within DoD (Project No. 2AB-0016), October 23, 1992." All recommendations were proposed for Under Secretary of Defense for Acquisition (USD(A)) action.

PART II.A. Duplication, Redundancy, and Proliferation (Page 29)

1. Assign responsibility for development of policies and procedures related to investment, internal development, interoperability standards, modification of existing assets, and maintenance of catalogues regarding modeling and simulation activities within DoD. Army regulation 5-11 could provide the baseline for development of these DoD procedures.

Response: Concur provided that the recommendation in the report include a statement that corrective action is in process. Corrective action taken stems from the 21 June, 1991 , Deputy Secretary of Defense memorandum and USD(A) memorandum of 26 September 1991. These memorandum named the members of the DoD executive Council for Models and Simulations (EXCIMS) and designated the Director, Defense Research and Engineering as the chair. The draft DoDD 50XX.XX, "Modeling and Simulation" (herein referred to as DoDD 50XX.XX), currently in coordination, will continue the directions outlined in the memorandum and establish policies. DoDD 50XX.XX states that the USD(A) shall: (1) be responsible for strengthening the use of modeling and simulation within DoD, and (2) issue plans, policies, directives, procedures, and publications for management and advancement of modeling and simulation.

2. Develop a standard reporting procedure for starting new modeling and simulation efforts with a cost threshold exceeding $500,000 for input into a DoD-wide catalogue system and require all Components to comply with this procedure.

Response: Concur provided that the recommendation in the report include a statement that corrective action is in process. In addition to the efforts underway or planned due to DoDD 50XX.XX,

the Defense Modeling and Simulation Office is developing a prototype electronic bulletin board and repository with information clearinghouse capabilities such as catalogues, announcements, lists of significant events, and documents. Full operational capability is projected by June, 1993. A major component of the system will be a directory M&S catalogues.

3. Require that DoD Components establish formal oversight responsibilities and associated internal controls for modeling and simulation activities, based on Army Regulation 5-11, "Army Model and Simulation Management Program."

Response: Concur provided that the recommendation in the report include a statement that corrective action is in process. The intent of this recommendation was captured in the policy section of DoDD 50XX.XX, which states that "DoD component management systems for modeling and simulation oversight" are required.

4. Establish and maintain a common DoD modeling and simulation library with ready access to modeling and simulation users and developers.

Response: Concur provided that the recommendation in the report include a statement that corrective action is in process. DoDD 50XX.XX allows for the establishment of a common library. Specifically, the directive requires the development of common tools, methodologies,and databases in modeling and simulation; and, establishment of standards and protocols. The directive also requires the creation of a modeling and simulation information and data center.

PART II.B. Verification, Validation, and Accreditation (VV&A) (Page 44)

1. Using the Army Model and Simulation Management Program as a framework, develop policy, guidance, standards, and criteria by which verification, validation, and accreditation of models and simulations is to be accomplished.

Response: Concur provided that the recommendation in the report include a statement that corrective action is in process. DoDD 50XX.XX establishes requirements for verification, validation, and accreditation.

2. Require that models and simulations used for requirements definition, weapon system development, engineering, and testing and evaluation be verified, validated, and accredited in accordance with policy, guidance, standards, and criteria of Recommendation 1.

Response: Concur provided that the recommendation in the report include a statement that corrective action is in process. DoDD 50XX.XX will apply to all activities, however, it should be noted that it would be very costly to prescribe an enforceable single VV&A standard. The VV&A process needs to be defined by the component.

PART II.C. Configuration Management and Documentation

1. Establish a DoD-wide policy requiring configuration management plans for all future development of models and simulations.

Response: Concur provided that the recommendation in the report include a statement that corrective action is in process. The implementation of DoDD 50XX.XX includes the designation of a configuration management proponent in each modeling and simulation application.

2. Establish DoD-wide policy requiring adequate documentation for all future development of models and simulations.

Response: Concur provided that the recommendation in the report include a statement that corrective action is in process. DoDD 50XX.XX, establishes configuration management requirements for modeling and simulation developments. Specific documentation requirements include the development of a master plan and an investment plan.

ATTACHMENT 2

Director, Defense Research and Engineering Detailed Comments

The following comments are in response to the DoD Inspector General's "Draft Audit Report on Duplication/Proliferation of Weapons Systems' Modeling and Simulation Efforts within DoD (Project No. 2AB-0016), October 23, 1992.

GENERAL

The Director, Defense Research and Engineering (DDR&E), through the Defense Modeling and Simulation Office (DMSO), is in the process of implementing many of the recommendations stated in this draft audit. Because the report does not adequately address the plans and efforts already underway, the report is somewhat misleading and detracts from the important issues that are addressed. If a section was included in the report that addressed the current status and anticipated impact of the plans and efforts underway we feel the report would then become a useful management tool to assist in completing the corrective actions you have addressed.

Detailed comments on the Executive Summary (Pages i and ii) are not provided here. It is assumed that the Executive Summary will change to reflect any comments incorporated in the body of the report.

The comments that follow correspond to the sections, page numbers and paragraphs of the draft report.

PART I - INTRODUCTION

Background (Pages 1-2)

Paragraph 1: Recommend that the opening paragraph utilize the definitions that have been developed for modeling and simulation in the draft DoD Directive DoDD 50XX.XX, "Modeling and Simulation" (herein referred to as DoDD 50XX.XX). This would eliminate potential confusion to readers already familiar with the defense modeling and simulation program. (Model: A physical, mathematical, or otherwise logical representation of a system, entity, phenomenon, or process. Simulation: A method for implementing a model over time, as well as a technique for testing, analysis, or training in which real world and conceptual systems are reproduced by the

Paragraph 2: Recommend the DoD-approved definition of "operations research" be used in this report (JCS Pub 1-02, The Department of Defense Dictionary of Military and Associated

Terms). The remainder of the report appears to use "operations research" as a codeword for modeling and simulation. Using the standard definition for operations research it is not a codeword for modeling and simulation and we therefore recommend that the abbreviation "M&S" replace "operations research" throughout the document.

Paragraph 5: Recommend add "unnecessary" before duplication. Change "...for modeling in DoD..." to include "for strengthening the use of modeling and simulation in DoD..." This more accurately reflects the direction of the Deputy Secretary of Defense Memorandum, "Modeling and Simulation Management Plan", 21 June, 1991, and the responsibilities assigned to USD(A) in DODD 50XX.XX.

Objectives (Page 3)

Paragraph 1: The term "unnecessary investment in modeling" in the second sentence is not defined. "Necessary" and "unnecessary" modeling should be defined in this section so that the report's objectives are better understood.

Scope (Pages 3-5)

Paragraph 1: The method of statistical sampling should be explained and data provided.

Paragraph 4: This paragraph states that the audit scope was restricted to operations research assets. The conclusions are then generalized to all of M&S. There is no cogent argument offered to show that operations research models accurately reflect training and other models.

Other Matters of Interest (Pages 7-10)

Paragraphs 1-3: Recommend these paragraphs be omitted from this report as they are not germane to weapons systems' M&S. If retained, recommend that "M&S" be substituted for "operations research' throughout the section. These studies dealt with specific uses of modeling and simulation, not operations research. The statement "All three studies concluded there were managerial and technical difficulties in implementing operations research in the DoD" cannot be derived from the individual studies.

Paragraph 4: Recommend reword to reflect final version of report, "A Review of Study Panel Recommendations for Defense Modeling and Simulation", June 1992. Add "and completed for the DMSO" after "1992". The report should also mention that the IDA report recommendations provide the foundation for the work of DMSO and that each recommendation was categorized with regard to which DMSO general objective, application area, and technical objective it addressed.

PART II - FINDINGS AND RECOMMENDATIONS

A. DUPLICATION, REDUNDANCY, AND PROLIFERATION (Page 11)

Paragraph 1: The recommendations of Finding A state that the Under Secretary of Defense of Acquisition (USD(A)) should assign responsibility for development of policies and procedures for modeling and simulation. This section should be updated to reflect the Department's efforts. The 21 June, 1991, Deputy Secretary of Defense memorandum and the USD(A) memorandum of 26 September 1991 named the members of the DoD Executive Council for Models and Simulations (EXCIMS) and designated the Director, Defense Research and Engineering (DDR&E) as the chair.

The draft DODD 50XX.XX, currently in coordination, will continue the directions outlined in the memorandum and establish policies. DODD 50XX.XX states that the USD(A) shall (1) be responsible for strengthening the use of modeling and simulation within DoD, and (2) issue plans, policies, directives, procedures, and publications for management and advancement of modeling and simulation. In the "Policy" section, requirements are stated for: (1) a DoD modeling and simulation management and administrative structure, (2) a modeling and simulation master plan, (3) a modeling and simulation investment plan, (4) development of common tools, methodologies, and databases in modeling and simulation; and, establishment of standards and protocols, (5) a modeling and simulation information and data center, (6) general use applications in modeling and simulation, (7) verification, validation, and accreditation for modeling and simulation applications, (8) modeling and simulation applications to support DoD acquisition and oversight decision making, (9) DoD component management systems for modeling and simulation oversight, (10) DoD component representation in modeling and simulation applications, and (11) data and data administration for modeling and simulation applications to conform to established policies and procedures for data administration.

DISCUSSION OF DETAILS

DoD Management of Operations Research Activities (Pages 13-15)

Paragraph 3: Add the following statement to the end of the paragraph: "Two positive steps taken towards rectifying the deficiencies noted were the issuance of the Deputy Secretary of Defense memorandum dated June 21, 1991, Modeling and Simulation Management Plan and the Under Secretary of Defense (Acquisition) memorandum dated July 22, 1991, Establishment of the Defense Modeling and Simulation Office (DMSO).

Paragraph 5: Change "Interpretability" in the last line to "Interoperability".

Modeling and Simulation Libraries (Pages 25-26)

Paragraph 1: Agree that a master reference list should be established that will allow users to sort or create catalogues as needed, however the DMSO M&S Information System should be mentioned. DMSO M&S Information System is a prototype electronic bulletin board and repository with information clearinghouse capabilities such as catalogues, announcements, lists of significant events, and documents. Full operational capability is projected by June, 1993. A major component of the system will be a directory of M&S catalogues.

Potential Monetary Benefits (Pages 26-27)

Paragraph 2: Suggest you verify the $803M savings estimated by your technical assistant. The number appears high and may not include the cost of VV&A, which should have been included. If this is the case the number should be corrected throughout the report. Also, change "redundancy" to "duplication".

Conclusions (Pages 27-28)

Paragraph 2: Agree with the finding regarding absence of standards. However, we recommend that the following statement be added to reflect ongoing activity in this area: "There is currently a DMSO/DARPA effort to develop and implement the Aggregate Level System Protocol (ALSP) which will allow service developed wargames to communicate and interoperate." This capability has been demonstrated successfully in two major exercises.

B. VERIFICATION, VALIDATION, AND ACCREDITATION (Page 31)

Conclusions (Pages 42-44)

Paragraph 2: Recommend deleting the last sentence. It would be very costly to prescribe an enforceable single VV&A standard. The VV&A process needs to be defined by the component as prescribed in DODD 50XX.XX. In many cases, the cost of VV&A in time, personnel, and money could not be justified compared to the expected return on investment.

Paragraph 4: DODD 50XX.XX will apply to all DoD components.

C. CONFIGURATION MANAGEMENT AND DOCUMENTATION (Page 45)

Recommend adding a discussion that addresses the existing efforts in modeling and simulation standards that contribute to standardization and configuration management. These include: the Aggregate Level Simulation Protocol (ALSP), the Distributed

Interactive Simulation (DIS), and the Defense Simulation Internet (DSI).

Work on ALSP was begun in 1990 by the Defense Advanced Research Projects Agency (DARPA) and is currently chartered by USD(A) through the EXCIMS. The purpose of ALSP is to design an interface for multiple combat simulations. ALSP defines the process for DoD to connect diverse existing simulations and permit the geographical distribution of war game participants. Within ALSP, an Interface Working Group develops field interface protocols, coordinates Service and Joint Agency simulation enhancements, and provides system level software. ALSP supports an integrated multi-function training environment for joint and combined exercises through configuration management of ALSP protocols and system software, incorporation of new functionality, and deployment of tools, documentation, and system software. ALSP has been used to link the Army's Corps Battle Simulation (CBS) with the Air Force's Air War Simulation (AWSIM). The Navy and Marine Corps have also agreed to use ALSP as the interface between the Navy's new version of the Enhanced Naval Warfare Gaming System (ENWGS) and the Marine Corps's Marine Air-Ground Task Force (MAGTF) Tactical Warfare Simulation (MTWS).

Another DARPA effort, under DMSO sponsorship, is the DIS. When fully developed, DIS will allow dissimilar simulators distributed over a large geographical area to interact in a team environment. The simulators communicate over local and wide area networks. Since 1989, workshops, involving industry, academia, and government have been conducted at the University of Central Florida's Institute for Simulation and Training to develop a common standard for describing the form and types of messages to be exchanged between simulated entities in a DIS. A final draft standard was submitted to the Institute of Electrical and Electronic Engineers (IEEE) and has been issued as IEEE Draft Standard P1278.

Finally, with support from DMSO, DARPA and the Defense Information Systems Agency (DISA) are developing DSI. DSI is a high capacity network and supports a full spectrum of war fighting simulation interoperability activities. DSI is intended to be transitioned into a core component of DISA's Defense Information Systems Network to ensure that DoD's next generation corporate network will meet the needs of DIS. DSI is a high performance, wide area, packet switched network and supports the infrastructure for a DoD seamless warfighting simulation.

The standardization and configuration management controls embodied by the ALSP, DIS, and DSI will enable the communications and computing elements of DoD components to function as a seamless simulation system, and place the power of simulation at the components' disposal for training, acquisition, and mission support at costs significantly less than that required for separate simulations.

DISCUSSION OF DETAILS

Recommendations for Corrective Action (Page 52)

Change the opening sentence to "Corrective action for the deficiencies noted in this report can be accomplished with the issuance of DoDD 50XX.XX, this will:"

Comments from The Joint Staff

THE JOINT STAFF
WASHINGTON, DC

Reply ZIP Code:
20318-8000

J-8A 00064-93
22 January 1993

MEMORANDUM FOR THE DEPARTMENT OF DEFENSE INSPECTOR GENERAL

Attention: Director for Acquisition Management

Subject: Audit on Duplication/Proliferation of Weapon Systems' Modeling and Simulation Efforts Within DOD (Project No. 2AB-0016)

1. The subject Audit provides an excellent assessment of the status of DOD policy and guidance in the areas of Modeling and Simulation (M&S) standards and Verification, Validation, and Accreditation (VV&A) to date. Our review of the Audit disclosed three points for which we offer clarification and request correction in the Audit's final report.

2. Page 2, last sentence. Change to: "This initiative is to promote the introduction of new modeling and simulation technology into joint operational use and to assist the Force Structure, Resources, and Assessment Directorate, J8, to consolidate the modeling and simulation plans of the commanders in chief, cut costs, and reduce duplication."

REASON: Accuracy. The draft Audit confuses the purpose and responsibilities of the new Joint Simulation and Interoperability Division (JSID), J-7, with the responsibilities of the Force Structure, Resources, and Assessment Directorate, J-8. Responsibilities for management of joint M&S including joint M&S planning and resource allocation are assigned on the Joint Staff to the J-8. Copies of the pertinent J-7 and J-8 mission statements from Joint Admin Pub 1.1, "Organizations and Functions of the Joint Staff," are enclosed. JSID was established by J-7 to "promote the application of M&S" and to assist the J-8's management of joint M&S by providing an operational perspective on the need for new M&S capabilities. The DOD IG Audit is directed primarily at joint M&S management functions that are managed by the J-8.

3. Page 15, 2nd paragraph, last two lines. Delete, ", would establish a Joint Simulation and Interoperability Division."

REASON: Accuracy. J-7/JSID is already established and its missions and functions codified in Joint Admin Pub, 1.1, "Organizations and Functions of the Joint Staff." The proposed MOP 68 does not change the organization of the Joint Staff.

4. Page 74 and 84, References to the JAWS and BUILDUP models. Change the "0" ratings to "N/A."

REASON: Clarity. The JAWS and BUILDUP models were cancelled in 1989 and 1980 respectively. The JAWS model was never used. A more accurate assessment of the status of both models would be "Not Applicable." A rating of "0," meaning "None," conveys the impression of a deficiency, since the "0" rating was also used to grade operational models that were deficient in Accreditation and Configuration Management.

5. The corrections offered may help the Audit convey a more accurate picture and help reduce confusion surrounding Joint Staff management of M&S. CDR Robert G. Brewer, USN, (703) 614-7881, is my designated point of contact for this action. Please contact him if any further assistance is required.

CONRAD C. LAUTENBACHER, JR.
Rear Admiral, USN
Director for Force Structure,
Resources, and Assessment

Enclosure

Comments from the Department of the Army

DEPARTMENT OF THE ARMY
OFFICE OF THE UNDER SECRETARY
WASHINGTON, D.C. 20310-0102

December 31, 1992

SAUS-OR

MEMORANDUM FOR IG, DOD (AUDITING)

SUBJECT: Audit Report on Duplication/Proliferation of Weapon Systems Modeling and Simulation Efforts Within DoD (Project No. 2AB-0016)

Reference is made to your memorandum of 23 October 1992, subject as above, which requested review and comment on subject draft audit report.

The Army fundamentally agrees with the general thrust of the audit report and is pleased to see that our efforts to improve the management of modeling and simulation have been assessed as being acceptable as a model for other sectors of DoD. In our judgement, however, the report in its current form contains substantive errors and misuses of terminology which materially detract from its overall credibility. We recommend that the report be rewritten and then restaffed for comments prior to being issued. There are three principal reasons for this:

a. The report does not uncover any issues that are new to the modeling and simulation community. The coordination of modeling and simulation efforts; the validation, verification, accreditation, and configuration control of models and simulations; and the adequate documentation of models and simulations are all difficult problems that have been with us for a long time. The background presented and conclusions reached, in each of the three major areas discussed, indicate an incomplete understanding of the issues involved. For example, the definitions of validation and verification and the methods used to apply them to models and simulations are much debated topics within the community. The fact that there is no DoD mandate to perform VV&A is not the reason that developers do not seem to do an adequate job in this area. Quite the contrary, there is much serious professional discussion and debate about precisely what constitutes adequate VV&A and how and when to apply the various techniques that are available. As it is presently cast, the report does not recognize the ongoing nature of the activities which are making incremental advances toward resolving these and other essentially technical issues. Bureaucratic fiat will not resolve the issues involved.

b. The baseline sample used for the audit was extracted from a document that is not reliable, complete, or current. In

SAUS-OR December 31, 1992
SUBEJCT: Audit Report on Duplication/Proliferation of Weapons Systems Modeling and Simulation Efforts Within DoD (Project No. 2AB-0016)

addition, models not used in the weapons systems acquisition process were intermingled with and judged against the same criteria as those used in the weapons system acquisition process. Models and simulations used in the product development stages of the acquisition process normally do not include representations of the entire combined arms team at item system level because of the differing nature of the problems and alternatives being analysed. However, those models and simulations used for Cost and Operational Effectiveness Analyses (COEA) frequently include both item system and aggregate level representations of forces in the combined arms team. The best current Army source of these combat effectiveness models is the TRADOC Model Catalog, which is formally revised and updated on a two-year cycle. In addition the Army's FORCEM and TRANSMO models are not used for weapons systems analysis at any level, but are used primarily in the total force programming arena.

c. Throughout, the audit report inappropriately attempts to use the term "operations research" as a synonym for "modeling and simulation". In many instances the interpretation of the scope of the audit is significantly altered by this incorrect substitution. Models and simulations are merely one set of tools used by operations research practitioners, and it is incorrect to infer that their use defines what operations research is all about. The detailed Army comments, which are attached at Enclosure 1, include sections which attempt to correct most of these errors. After they are applied, however, there may be other sections of the report which will need to be rewritten to ensure that the proper context of the audit is maintained. Therefore, we recommend that the report be rewritten and then restaffed in its modified form.

The findings and recommendations are not directly addressed to the Army. We generally concur with the recommendations insofar as they address the need for integrated policies at the DoD level. We do not agree that all of the specific findings are justified for the reasons stated above, the details of which are found in the specific comments at Enclosure 1.

My POC is COL Gilbert Brauch, Chief, Army Model and Simulation Management Office, (703)607-3375, FAX (703)607-3381, DSN 327-xxxx.

Walter W. Hollis
Deputy Under Secretary of the Army
(Operations Research)

Enclosure
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Comments from the Naval War College

DEPARTMENT OF THE NAVY
NAVAL WAR COLLEGE
NEWPORT, RHODE ISLAND 02841-5010

18 December 1992

From: Director, War Gaming Department
To: Inspector General, Department of Defense (Attn: Mr. Raymond Spencer)

Subj: COMMENTS ON DRAFT AUDIT REPORT, PROJECT NO. 2AB-0016 (DUPLICATION/ PROLIFERATION OF WEAPON SYSTEMS' MODELING AND SIMULATION EFFORTS WITHIN DOD)

Ref: (a) Draft of a Proposed Audit Report

1. In compliance with reference (a), the following comments are submitted.

a. Concur with all recommendations to control the procurement and development of models and simulations. However, the threshold reporting criteria of $500,000 should be lowered. This would provide for greater degree of asset reporting. Numerous models and simulations would otherwise not be reported.

b. Concur with all recommendations to establish policies, plans, and procedures relative to verification, validation, and accreditation of models and simulations.

c. Concur with all recommendations to establish policies, plans, and procedures to effectively institute configuration management and to obtain documentation.

2. All recommended controls exist for the Enhanced Naval Warfare Gaming System (ENWGS), which is the Navy's primary war gaming facility. ENWGS is sponsored by OPNAV, managed by the Space and Naval Warfare Systems Command, and would meet the objective criteria for this audit. The "SAB" (Surface-Air Battle) model, which the subject report references, is not a model used for engineering and weapons development purposes or for high-fidelity training. It was, but is no longer, used to support educational gaming wherein reasonable results, measured by professional judgement and expertise against the gaming objectives, are the desired outcomes. Also, auditors were provided with "Operating Instructions - Surface and Air Battle". This document provides an overview of the model, and details the user interface requirements to include data structures, game data preparation, and execution.

J. M. Burscher

J. M. BURSCHER

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INTERNET DOCUMENT INFORMATION FORM

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Inspector General, Department of Defense
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